Techno-Cultural Environments and the Strong Thesis of the *Metaphoric Body*

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Abstract

In this article I will define, examine and expand the thesis of the *Metaphoric Body*. The thesis is based first and foremost on the ideas of Marshall McLuhan (1911-1980). In his work McLuhan focused on the study of media and technology and their impact on human perception and society. He identified the *Man*-made environment as an *extension* or *prosthesis* of the body and studied the interaction between the two domains, the *body* and the *Man-made environment*, as a bidirectional, metaphoric interaction. The interaction can be defined as follows: (a) technology is modeled on the body, i.e., we reshape the environment and design artificial environments as functional *extensions* of the body (b) the body is modified perceptually, conceptually, theoretically and even physically due to the interaction. This interaction is manifested in the *body machine* metaphor, whose development I examine using McLuhan's insights.

Metaphors and Reciprocal Interaction

In traditional modern philosophy, metaphor was considered as an incorrect, deceiving speech form. The objectivist program - from Thomas Hobbes and John Lock, through positivism of the 19th and 20th centuries, and to contemporary conservative intellectuals - tries to demonstrate that one should and could get rid of metaphors, especially when it comes to serious subjects, such as philosophy and science. In the past decades the objectivist program was challenged and replaced by non-objectivist

approaches. The origins of the non-objectivist approaches can be traced to the ideas of I.A. Richards (1936). Following Richards, Max Black called his approach an *interaction view of metaphor*. According to the interaction view, the meaning of a metaphor, like *man is a wolf*, is a result of the interaction between the *principal* subject- Man and the *subsidiary* subject- Wolf, or in the terms of the conceptual metaphor theory between the *target* domain and the *source* domain (Black 1962, 38-47; Black 1998; Lakoff and Johnson 1980). The subsidiary subject / source domain allows us to understand the principal subject / target domain in a new way. We experience the principal subject through the filtering "lenses" of the subsidiary subject. The non-objectivist approaches determine that it is impossible to reduce the idea behind any metaphor by two separate ideas or by two *purified* literal sentences. It seems that this basic idea characterizes all the new non-objectivist approaches to metaphors, despite all the differences between them. Moreover, the non-objectivist scholars would all accept the following assertion as well: metaphors do not merely represent existing similarities or objective similarities, but, rather, they actively create new meanings, new insights and similarities. The non-objectivist views are based on the assumption that our knowledge, concepts and theories about the world are constructed metaphorically as a result of interplay between physical experiences, perceptions, mental creativity and cultural experiences. Our knowledge about the world, then, does not simply or neutrally reflect the *objective* structure of the world.

Metaphors are usually asymmetric. For this reason Richards and Black distinguished the principal subject from the subsidiary subject. Yet asymmetric relationships are not equivalent to the absence of reciprocity. In the metaphoric process both domains are modified and not just the principal subject / target domain. This phenomenon stems

from the following aspects: (a) the subsidiary subject, or the source domain, is perceptually modified at least in its context, connotations and associations (b) metaphoric interactions involve transfer of values from source to target and from target to source (c) the source and target domains of the metaphors are fused together in single imaginary events that may generate transformations in the two domains (d) feedback transfers are needed in the process of metaphoric comprehension (Amit 2012, 8-39).

The long history of the *body machine* metaphor is a good example of reciprocal interaction. In the following passage from *Letter on the Deaf and Dumb*, Denis Diderot descries *man* as an *automaton*. The two domains of the metaphor appear in a single imaginary event (*condensation*) which generates *transformations*, or in the terms of Blending theory, information, structures and scenarios from the different domains are *fused* in a mental blend space.[1] Elements from the domain of the *machine* merge with the *body* and the *body* is transformed into the *body machine*:

> Sir, think of man as an automaton, as a sort of walking clock; let the heart represent its main spring, and the other organs inside his chest the other principal pieces of the movement. Imagine in his head a bell furnished with little hammers and from these hammers an infinite multitude of threads stretching out in every direction and terminating at points all over the case (Diderot 1966 [1751], 32).

The condensation and transformation of the two metaphoric domains are visually manifested in Fritz Kahn's book *Das Leben des Menschen* (1927). Kahn's illustrations presented the industrial view of the body to the general public. Industrialization, as well as its impact on biology, peaked in the 20th century, although the industrial order in biology already began to develop at the end of the 18th century.

One of Kahn's illustrations, *Man as Industrial Palace*, portrays different functions of the body - respiration, circulation, the functions of the brain, digestion and metabolism - as a collection of industrial processes executed by machines and workers. The fusion of elements from the domain of the *body* and the domain of the *factory* in the illustration manifests the interaction between the life sciences and industrial society. The saliva, for example, becomes a kind of a chemical solvent that a worker in the factory sprays on food. The muscles become engines. Since the domain of the factory include workers, human beings function as little devils within the human body or as ghosts in the machine. In 2011 the poster of *Man as Industrial Palace* was animated by Henning Lederer.[2]

Figure 1 shows an illustration from Kahn's book of the processes that take place between the sense of smell and the salivary reflex. The illustration presents the domains of the *industrialized body* in a single imaginary event in which the organs and functions of a human head were transformed into machines and industrial processes. As a kind of process which is based on the logic of a production line, the smell of roast meat leads to the secretion of saliva from a salivary gland. The process consists of a sequence of different operations in different regions of the head and the brain, such as a laboratory that analyzes the smell, a control center, measuring instruments, containers of chemicals, metal pipes and sprinklers, workers and laboratory technicians or scientists. In the terms of blending theory, the image is a kind of a blended space that enables the *fusion* of elements from different domains within a metaphorical situation. As a result of the fusion, biological functions are performed by industrial means.

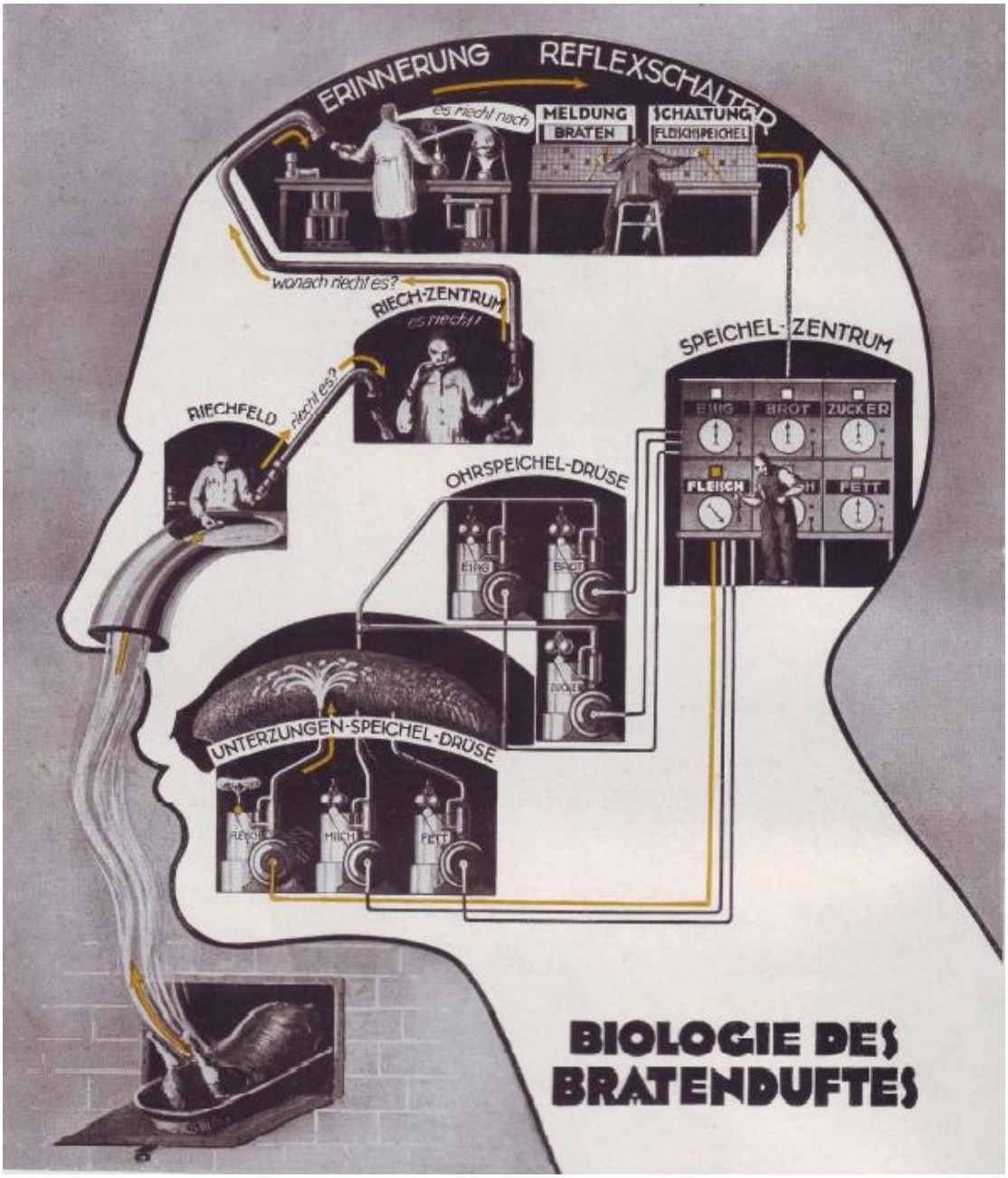

FIGURE 1 The connection between the sense of smell and the salivary reflex as an industrial process (Kahn 1927, vol. 3, 96-97, plate XV)

Pictorial examples that illustrate the work of the metaphorical imagination, i.e., the reciprocal interaction of the two domains and the phenomena of condensation and

transformation, can be found in different discourses and fields. Let us examine an example from the opening monologue of *The Tonight Show* (see figure 2):

"Here is some good news from the world of medicine, Kev. Scientists now believe they have located the part of the human body that causes obesity. I believe it's called your mouth. No; scientists have identified the gene which they claim contribute to obesity… There's a normal strand of DNA; that's the normal strand [a picture of a standard digital illustration of DNA]. Show the strand that has the obesity gene. See, it's a curly fry [a picture of a DNA molecule made out of a curly fry]." (Jay Leno, *The Tonight Show with Jay Leno*, *NBC*, 13-4-2007).

Through the metaphoric interaction, the DNA molecule in the first picture is transformed into the curly fry DNA that appears in the second picture. Thus both the source and target domains are transformed. Apparently the gene and the genetic explanation are the target domain, but actually the gene becomes a symbol of obesity epidemic, food industry and consumer culture in the US. Hence both subjects serve as source and target for each other. The domains of the metaphor are not pure literal categories from the outset. In the scientific discourse, for example, the concept of *gene* is constructed using electronic metaphors, such as *information*, *code* and *computer program*.

FIGURE 2 Metaphorical transformation. Left picture: a standard illustration of DNA.

Right picture: a curly fry DNA

Metaphors, Embodied Experiences and Extensions

According to the *interactionist* or *experientialist* approaches, the metaphorical construction of concepts depends on physical and embodied experiences and on empirical data (Lakoff and Johnson 1980, 14, 19-24, 192-194; Johnson 1987; Lakoff 1987; Lakoff and Johnson 1999; Kövecses 2005; Gibbs 2003; Gibbs 2006; Barnes et al 1996, chap.3). Three examples: (a) a possible physical basis for the *happy is up*; *sad is down* metaphor (e.g., *I'm feeling up; my spirit rose*): sadness and depression usually involve drooping posture, while being happy and feeling good usually involve erect posture (b) a possible physical basis for the *conscious is up*; *unconscious is down* metaphor (e.g., *Wake up*; *he fell asleep*): human beings like most mammals sleep lying down and stand up when they awaken (c) a possible physical basis for the

affection is warmth metaphor (e.g., *"We have a warm relationship"*): since infancy the emotion domain expressed by loving embraces is simultaneously activated with the temperature domain. Finally, it should be emphasized that metaphors are not confined to the verbal domain. We design technologies and artifacts so they would fit the basic metaphors of our cultures. Graphs and thermometers, for instance, follow the *more is up* metaphor (Lakoff 1998, 241). The computer screen is designed and perceived as a desk with objects that we can *touch* and *point* them (Coyne 1995, 280-286).

The dependence of metaphors on empirical data is clearly illustrated in the *body machine* metaphor. For example, in early modern age the *body is a clock* metaphor became dominant, but many scientists and intellectuals observed the failures of this metaphor with respects to living beings. John Locke was one of these intellectuals. Based on a mixture of moral and experiential considerations, he argued that in some respects the *body machine* differs from mechanical automata (Locke 1849 [1690], 31, 94, 219). First, consciousness, morality and freedom cannot be attributed to mechanical automata. For Locke, "denying freedom to mankind" was equivalent to "making men no other than bare machines". Similarly, he believed that at least some species of animals have a low degree of consciousness and reason, and therefore they are not "bare machines". During the period which I will define below as the first mechanistic phase, two of the main problems of the *body machine* metaphor were the lack of an internal power source and the lack of an organizing force in mechanical automata. Locke defined these experiential problems of the mechanical metaphor as follows:

The case is not so much different in brutes, but that any one may hence see what makes an animal, and continues it the same. Something we have like this in machines, and may serve to illustrate it. For example: What is a watch? It is plain it is nothing but a fit organization or construction of parts to a certain end, which, when a sufficient force is added to it, it is capable to attain. If we would suppose this machine one continued body, all whose organized parts were repaired, increased, or diminished, by a constant addition or separation of insensible parts, with one common life, we should have something very much like the body of an animal, with this difference, - that in an animal the fitness of the organization, and the motion wherein life consists, begin together, the motion coming from within; but in machines the force coming sensibly from without, is often away when the organ is in order, and well fitted to receive it (Locke 1849 [1690], 219).

Now, following the ideas of Marshall McLuhan, I would like to introduce a *stronger* thesis, or a more radical approach, concerning the *Metaphoric Body*. McLuhan's theory is not part of the different discourses on metaphors in philosophy, psychology or cognitive sciences, but part of the discourse in media studies and it deals with the impact of technologies on human perception, society and culture. According to the radical approach of McLuhan, the human environment is modeled on the human body and at the same time it modifies the body perceptually, conceptually, theoretically and even physically. Thus the interaction between the domains is reciprocal (McLuhan 1962; 1964; McLuhan and McLuhan 1988). Similar to Black, McLuhan was influenced by I. A. Richards' theory of metaphor. According to McLuhan, a metaphor is a complex of analogical relations, or a translation and a transformation of experience that enable one to see one set of relations through another (McLuhan 1964, 59-60). McLuhan was the first intellectual who had begun to formulate an inclusive theory which defines the interaction between the *body* and the *Man-made environment* as a bidirectional, or multi-directional, metaphoric interaction. But what is the experiential basis for the assertion that the human environment is modeled on

the human body? Well, this experiential basis depends on the function and essence of artificial products with respect to the people who design and use them. Technologies function as *extensions/ prostheses/ amplifications* of the human body, i.e., they are *extensions* of organs, senses, bodily functions or processes.

As verbal metaphors translate certain relations from one domain to another, artificial products materialize certain aspects of the human body in the environment: *clothes are extensions of the skin* and in general they assist the mechanism of thermoregulation; *forks are extensions of palm and fingers*; *books and libraries are extensions of memory*; *refrigerators extend the capacity and the ability of the body to store food or energy* (food and energy in the body are stored on different levels, e.g., fat tissues); *telescopes, microscopes and lenses are extensions of sight*; *weapons are extensions of fists, legs, teeth, nails, and any other aspect or function of the body which is used in fighting*; *wheels are extensions of legs in motion*; and so forth (McLuhan 1964; McLuhan and McLuhan 1988).[3] Generally, one can define simple tools as motionless *extensions* of organs, and machines as *extensions* of bodily functions or processes:

> As contrasted with the mere tool, the machine is an extension or outering of a process. The tool extends the fist, the nails, the teeth, the arm. The wheel extends the feet in rotation or sequential movement. Printing, the first complete mechanization of a handicraft, breaks up the movement of the hand into a series of discrete steps that are as repeatable as the wheel is rotary (McLuhan 1964, 152).

McLuhan adopted the idea of *extension* from the work of the anthropologist Edward T. Hall. Hall himself got the idea from the architect and engineer Buckminster Fuller (McLuhan 1987, 287, 308, 515). Yet the origins of this idea can be traced back to the

insights of 19th century intellectuals and scientists, such as Samuel Butler, Thomas Huxley, Ralph Emerson and Henri Bergson. Following the publication of Darwin's work, Butler began to write about the interrelationships between humans and machines and their joint evolution. According to Butler, machines are *mechanical limbs* that enhance human abilities and modify the evolution of mankind, while the propagation and evolution of these machines depend on humans (Butler 1921 [1863; 1865], 42-53; Butler 1968 [1872], 189-219). Butler's view echoes in McLuhan's *Understanding Media*, especially in the following passage: "Man becomes, as it were, the sex organs of the machine world, as the bee of the plant world, enabling it to fecundate and to evolve ever new forms" (McLuhan1964, 46). Later McLuhan related to the thoughts of Emerson on the interrelationships between humans and machines (McLuhan and McLuhan 1988, 94-96). Emerson summarized the idea that the design of artificial environments depends on the anthropomorphic perception:

> Our nineteenth century is the age of tools. They grew out of our structure. "Man is the meter of all things," said Aristotle; "the hand is the instrument of instruments, and the mind is the form of forms." The human body is the magazine of inventions, the patent office, where are the models from which every hint was taken. All the tools and engines on earth are only extensions of its limbs and senses. One definition of man is "an intelligence served by organs." Machines can only second, not supply, his unaided senses. The body is a meter (Emerson 1968 [1870], vol. 7, 157).

Additionally, Emerson was aware of the reciprocal interaction between humans and machines:

> Machinery is aggressive. The weaver becomes a web, the mechinist a machine (Emerson1968 [1870], vol. 7, 164).

McLuhan argued that the electronic media is *the second great extension* of the central nervous system (McLuhan 1964, 57, 269). According to this metaphor, in the electronic age humans *wear* their brains outside their skull and their nervous systems outside their skins. The *first great extension* of our central nervous system is the spoken word, which amplifies mental abilities, translates all senses, even to one another *(loud color, bright sounds*), and serves as an *extension* of consciousness in the social world. Let us take the computer as an example *of the second great extension*. The computer enhances the functions of the brain, i.e. mental and cognitive abilities, such as memory, calculation, information processing, analysis of situations and decision making. However, the interaction is not unidirectional but reciprocal: the computer which is the target domain became a model of the brain and the body. Consequently, as the debate between John Searle (1990) and Paul Churchland and Patricia Smith Churchland (1990) demonstrates, the following questions arise in the cognitive science: is the brain a certain type of computer? Can we define consciousness and intelligent behavior as computer programs?[4] Moreover, the metaphoric interaction is not limited to the characters that are enhanced by the electronic technology, e.g. the senses or mental and cognitive abilities: the new technology can serve as a metaphorical model for any other character of the body, for example, in molecular and evolutionary biology the DNA is described as a computer program (see, for example, Dawkins 2000 [1986]).

My interpretation of the *extension* idea is as follows. Technologies are functional *extensions* of the body which are designed by metaphorical thinking. In the terms of the conceptual metaphor theory, the *body* is the source domain and the *environment* is the target domain: we design the environment according to the functions of the body,

thus creating the artificial environment. The *target* domain in this case is designed to serve the source domain as an *extension*/*prosthesis*. A shovel, for example, is an extension of our hand, i.e., a physical metaphor that translates the environment into an artificial hand. We should notice that the body is only the fundamental source domain for its *extensions*. In order to create the *extensions* we use other source domains. First, when we design a technology we use basic cultural metaphors, e.g., the *more is up* metaphor. Secondly, we physically and conceptually use the bodies of animals and other organisms to design artifacts and technologies. For instance, skin of animals is used in the production of clothing, i.e., we produce tanned leather as an extension of the human skin. Viruses are used in the production of vaccines that strengthen the immune system. Organisms also serve as models of *extensions*, for instance wings of birds and insects serve as models of aircraft wings (airplanes enhance the movement of the body and some aircrafts are also used as extensions of fighting abilities and the senses, e.g., surveillance aircrafts). Thirdly, we design technologies using other technologies as metaphorical sources, e.g., the computer screen as a desk.

Is the idea of *extensions* metaphorical? The answer is yes. Theories that explain the *metaphorical* aspects of human knowledge are metaphorical themselves. As a non-objectivist it would be ridiculous if I would argue otherwise. The conceptual metaphor theory (Lakoff and Johnson 1980; Lakoff and Turner 1989) and its basic concepts (*source* and *target domains*) are metaphorical. Blending theory (Fauconnier and Turner 2002; Grady et al. 1999) and its basic concepts (*input*, *generic*, and *blended spaces*) are metaphorical. The *extensions* theory, as well, is not based only on *simple* observations: as the explanations and citations above show, the idea that technologies are *prostheses* of the body depends on metaphorical perception and

theoretical interpretation. Nonetheless, metaphors are not arbitrary: the experiential basis of metaphors consists of empirical data and social-cultural-technological conditions. The question is how does the metaphor deal with empirical data and what are the insights and advantages of one metaphorical framework in comparison to alternative metaphorical frameworks?

The reciprocal interaction between the two basic domains of the *body machine* metaphor is flexible and multidirectional:

- (1-a) Technology is designed as an *extension* or *prosthesis* of the body which enhances and amplifies organs or bodily functions by translating them into a new medium / a new form.
- (1-b) Organs and bodily functions can serve as models for the design of technologies that in return serve as extensions of different organs or bodily functions.
- (2) Technology serves as a perceptual/conceptual/theoretical/physical model for experiencing, understanding and redesigning the body as a machine.

Metaphorical relationship is not symmetrical. In most cases, people tend to use the *body machine* metaphor without being aware that the technology which appears in their metaphor is an *extension* of certain aspects of the body. Even when a person builds a machine as an *extension* of certain aspects of the body, he or she may still freely use the *body machine* metaphor in both directions. For example, Norbert Wiener, one of the founding fathers of cybernetics, discussed the connection between negative feedback and organic homeostasis (Wiener 1954, 95-96), although the negative feedback is not an *extension* of homeostasis but of the mental-manual

control.[5] In other words, Wiener focused in this case on the connection between (1-b) and (2), and he was not limited by the connection between (1-a) and (2). On the other hand, when inventors develop a technology, or when cyberneticists, biologists and MDs develop cyborgs, they focus on (1-a) and not just on (1-b) and (2). The overall pattern of the interaction between the *body* and the *machine* depends on many other domains and metaphors. On the one hand, we utilize natural, organic and social sources in order to create the extensions. On the other hand, the technological extensions modify the natural, organic and social environments in many respects, such as the creation of the artificial environment, ecological changes, the development of the *body machine* metaphor, the creation of farm animals and cybernetic organisms, and the appearance of perceptual and socio-cultural modifications which are related to media and technology ("The medium is the message"). In short, the *body machine* metaphor, if I may use the holistic metaphor of the electronic order, is part of a *total field* (see below).

The Development of the Body Machine Metaphor

Technologies are not passive *extensions* of the body. The metaphoric interaction between technology and the body is reciprocal. Technologies are designed as extensions that translate the body into new forms. At the same time they modify the way we perceive and experience the body and, moreover, they can physically redesign the body. Thus, the body and the machine always serve as *source* and *target* for each other. In the following sections the focus will be on the machine as a *source* and the body as a *target*.

Before I will analyze the perceptual, conceptual and theoretical modifications that occur within the domain of the *body* as part of the interaction between the domains of the *body machine* metaphor, I would like to relate to the physical modifications of the body which stem from its interaction with the machine. *Extensions* that are physically linked to the human body are called *prostheses*. Electronic prostheses are the ultimate expression of the reciprocal interaction between the body and the machine, and they physically redesign the body: in the past tools and the artificial environment in general indirectly contributed to the evolution of the body, but through the electronic prostheses we directly reconstruct the body as a machine. In our time the brain is being physically redesigned using chips and electrodes, for example, the brain of humans and monkeys that control robotic arms via brain-machine interfaces (Birbaumer et al. 1999; Chapin et al. 1999; Wessberg et al. 2000; Carmena et al. 2003; Friehs et al. 2004; Velliste et al. 2008), or the visual cortex of the blind man that contains electrodes attached to external miniature TV camera, an ultrasonic sensor and a small computer (Dobelle 2000). Therefore the term ***ex****-tension* does not accurately capture the characteristics of the electronic *prosthesis*. With the appearance of the cyborg, the analogical relations of the body and the machine were replaced by metonymic and synecdochic relations, that is, relations between parts of the *same* domain or the *same* system. The clear distinction between the domains of the *body machine* metaphor has disappeared. Technology has become part of the physiological system and feedback mechanism of the body. Already at the end of the 1950s Manfred Clynes and Nathan Kline designed the prototype of the cyborg, using a rat with an implanted osmotic pump that injected chemicals to the rat's body with the purpose of modifying and regulating its homeostatic states (Clynes and Kline 1995

[1960]). Today, recombinant DNA technology and the cloning technique transform the body into an *imploded prosthesis* of itself. Through cloning the body can potentially replicate itself, a function that could have never existed under the conditions of sexual reproduction.

McLuhan's assertion that "The medium is the message" (McLuhan 1964) is very much relevant to the history of the *body machine* metaphor. According to McLuhan, the characteristics of new media and new technologies become dominant from two complementary aspects: the socio-cultural aspect and the mental-psychological aspect. Generally, McLuhan divides the history of the West into four main periods: (1) preliterate / tribal culture (2) literate- phonetic alphabet/ script culture (3) print - highly-literate / industrial culture (4) electronic / postindustrial culture.[6] McLuhan's grand-narrative is based on two major categories: *acoustic space* (or *audile-tactile space*) and *visual space*. The concept of *acoustic space* refers to the perception, thought and social organization in preliterate cultures, which are characterized by mimesis, contextual thought, tribalism, lack of individualism and holism. Fragmentation and specialization appear in these cultures only on a small scale. Basically, *acoustic space* indicates the existence of interplay between all the senses without dominance, although McLuhan sometimes claims that in preliterate cultures the ear can dominate the eye. As a spatial metaphor, *acoustic space* is a pre-Euclidean, inhomogeneous spherical space, characterized by resonance, intervals and metamorphic flux. According to McLuhan, the phonetic alphabet had shifted the balance of senses: the characteristics of the phonetic alphabet and the bias towards the visual sense created the *visual space* (*visual space* should not be confused with the visual sense *per se*). *Visual space* is the world of the literate people. As a spatial

metaphor, *visual space* is an abstract, homogenous, continuous, static, infinite Euclidian container. It is the *pure space* of John Locke or the *absolute space* of Isaac Newton. McLuhan distinguishes script culture from print culture: *visual space* was formed with the development of the phonetic alphabet, but it was modified and became much more dominant with the development of print culture and industrial society. However, the new electronic technology and media, cybernetics, contemporary field and systems theories are characterized by totality/holism, *implosion*, simultaneous operations, feedback loops, circularity and flexibility. Thus, the electronic environment, or *neo-acoustic space*, reverses the mechanical and industrial trends and retrieves in a new form some of the main characteristics of preliterate *acoustic space*. As a spatial metaphor, *neo-acoustic space* is the post-Euclidean space as manifested in the theory of relativity or quantum theory (Carpenter and McLuhan 1960; McLuhan 1962; McLuhan 1964; McLuhan and McLuhan 1988; Ong 1982).[7] According to McLuhan:

> After three thousand years of explosion, by means of fragmentary and mechanical technologies, the Western world is imploding. During the mechanical ages we had extended our bodies in space. Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned (McLuhan 1964, 3).[8]

The spatial metaphor of *explosion*/*implosion* describes two opposite historical trends and McLuhan's claim is that the new electronic environment had begun to reverse the fragmentary and mechanistic trends that peaked in the last centuries and dominated the industrial society. In other words, McLuhan's metaphor determines that in the electronic age *the fragments implode* and totality reemerges in society and in human perception. McLuhan's most familiar idea in this context is the shrinking of the world

to a *global village* (see, for example, McLuhan 1964, 92 -93), or, as he later called it, the *global theater*.

The most relevant aspect to this discussion may be called *technological implosion*. In the last decades the electronic flexibility is manifested by multimedia, computers and the World Wide Web, that *implode* old technological functions through a total system. The new electronic systems merge the functions of the book, the typewriter, the mail, the newspaper, television, music, telephone, commerce and trade, medical exams etc. Despite the existence of some technical problems, the new trend is to integrate and *implode* different devices and functions in a single electronic gadget: the integration of numerous tiny transistors into small electronic chips enables the design of electronic gadgets like the cellular phone which is also a calendar, a camera, a calculator, a word processor, a radio, an interface to the internet, etc. The *technological implosion* does not stop here. In the electronic age, as mentioned above, the technological *extensions imploded into* the body via the cyborg and the cloning technique. Moreover, Genetic engineering, synthetic biology and tissue transplanting techniques also lead to an *inter-species implosion*, that is, the creation of human-animal hybrids through genetic engineering, synthetic biology and stem cells transplantation, e.g. microbes and rabbits with human genes or insects and goats with spider genes, or, alternatively, the injection of human neural stem cells into the brains of mice, rodents, monkeys, and the injection of human stem cells from bone marrow of adults or from embryo lines into fetal sheep. *Inter-species implosion* serves the medical and biological research, medical industry, food industry, and it has other industrial applications, e.g., organisms with spider genes that produce spider silk for different purposes.

Based on the insights and grand-narrative of McLuhan, one can identify that the development of the *body machine* metaphor and the perception of the body in the life sciences is synchronized with the development of techno-cultural environments (Amit 2012). Three major techno-cultural orders can be defined in regard to development of the *body machine* metaphor:

(a) The *organic order*.[9] This order characterized preliterate culture and even script culture. Although the analytic approach and mechanical metaphors had already appeared in script culture, they were still subordinate to the organic framework.

(b) The *mechanistic order*. This order characterized modern, highly literate, industrial society. The mechanistic order in the life sciences can be divided into two main phases. The first phase, or the early mechanical approach, became dominant in the 17th century although its roots can be found in the 16th century. This phase declined in the second half of the 18th century. The roots of the second phase, or the industrial-chemical program, appeared in the last decades of the 18th century and it became dominant around 1840.

(c) The *electronic order*. This order characterizes the cybernetic post-industrial society. The roots of the electronic order in the life sciences can be found in *field* theory, *or organicism*, that appeared during the 1910s. During the 1940s the cybernetic-computerized program began to develop (see table 1).

TABLE 1

Techno-Cultural Orders and the Development of the *Body Machine* Metaphor

Techno-cultural order	Main Characteristics	Main Metaphors
The Organic Order Period / Culture: Preliterate culture and script culture	- Essence, - Wholeness, - Telos, - Holistic forces that regulate the body as a whole - The religious, mystic and animistic universe that resonated within the body	- The *psyche, soul,* the Chinese *qi* or equivalent holistic forces that *work through essence and purpose for the good of the living being* -The *macrocosm-microcosm* metaphor: the universe echoes in the human body and vice versa - *The body is an artifact designed by supreme forces and humanlike beings* - Early versions of the *body machine* metaphor under the *organic* perception; for example, when Aristotle describes the movement of the body as the movement of an automatic puppet working by springs, the movements described are still regulated by the *psyche*
The Mechanistic Order Period / Culture: Highly literate, industrial society 16th – 20th centuries	- Fragmentation (reductionism, specialization and atomism) - The efficient cause, chains of efficient causes - Sequential operation - Standardization (mechanical repetition of serial actions) - Determinism	- *The body is a mechanical automaton* : *The body is a clock* metaphor and simple mechanical models, such as pumps, sieves and grinding machines - *The industrialized body*: - *The body-engine* metaphor - *The cell-state* metaphor, cells as citizens/individuals in a nation-state /industrial society - *The division of physiological labor* - *Natural selection* and the logic of industrial capitalism

The Electronic Order Period / Culture: the cybernetic post-industrial society from the 20th century onwards	- Cybernetics and cybernetic implosion - Contemporary field and systems theories: totality, holism, systemic approach - Computerized systems, feedback, electronic *teleology* and flexibility	- *The body is a field* - *The body is a cybernetic-computerized system* and *the virtual body*: - *The body is an information pattern* - *DNA is the code of life*

See also the Appendix of this article in an additional file: Tables showing the Development of the *Body Machine* Metaphor:

http://hps-science.com/files/articles/tables-showing-the-development-of-the-body-machine-metaphor-in-the-life-sceinces.pdf

Hybrid Energy and Rear View Mirrors

Unlike Thomas Kuhn and Michel Foucault**,** who describe the development of science and culture as revolutions between *incommensurable paradigms* (Kuhn 1970), or as a process that occurs through *sharp epistemic breaks* (Foucault 1970), McLuhan describes the development of techno-cultural environments using the metaphors of *hybrid energy* and *rear view mirror*. He uses the metaphor of *hybrid energy*, with positive connotations, to describe the creative, fruitful interaction between old and new media in engineering and in arts. For instance, the interaction between the mechanical and the electronic in the 20th century yielded various technologies, from the cinema and the phonograph to cars and weapons (McLuhan 1964, 48-55, 342). McLuhan describes the transformation from script culture to print culture in a similar way: "The interface of the Renaissance was the meeting of medieval pluralism and modern homogeneity and mechanism – a formula for blitz and metamorphosis", or "Francis Bacon, PR voice for moderni, had both his feet in the Middle Ages" (McLuhan 1962, 141, 183, 186).

The metaphor of *hybrid energy* relates to the interaction of media or technologies as a physical-chemical process:

> The crossings or hybridizations of the media release great new force and energy as by fission or fusion (McLuhan 1964, 48).

At the same time *hybrid energy* is the product of mating in which media "spawn new progeny" (McLuhan 1964, 49):

The hybrid or the meeting of two media is a moment of truth and revelation from which new form is born (McLuhan 1964, 55).

On the other hand, McLuhan uses the metaphor of *rear view mirror*, with negative connotations, to describe anachronistic ways of thinking which are manifested in the assumption that new environments work according to the patterns of old environments. The lack of awareness of the characteristics and effects of new technological environments is the result of our tendency to experience and comprehend the present in terms of the past. In their book, *The Medium is the Massage* (1967), McLuhan and the graphic designer Quentin Fiore used a metaphorical image from a point of view of the driver. In this picture the driver focuses on the rear view mirror (the recent past), while the sights from the front window in the direction of movement (the present) are blurred. In the accompanying text McLuhan simultaneously uses the *rear view mirror* metaphor with the *marching backwards* metaphor:

We look at the present through a rear-view mirror. We march backwards into the future (McLuhan and Fiore 1967, 74-75).

Here are some examples of the rear view mirror effect. “Suburbia lives imaginatively in Bonanza-land” (McLuhan and Fiore 1967, 72-75). The *official culture* and the establishment are “striving to force the new media to do the work of the old” (McLuhan and Fiore 1967, 81, 94; McLuhan 1966, 107). The social theory of Marx, as McLuhan described it, can be defined as a rear view mirror: Marx focused on industrial production and he did not notice that the telegraph, i.e. the precursor of the

new electronic environment, promoted the formation of a new society (McLuhan and Fiore 1968, 4-5; McLuhan and Nevitt 1972, 67; McLuhan 1964, 38, 49). Cultural products, for instance science fiction movies like *Star Wars*, also project old patterns on the future (McLuhan and Powers 1989, 134). According to Neil Postman, the *rear view mirror i*s a way of thinking that is characterized by statements, such as "the car is just a fast horse" and "electric light is just like a powerful candle" (Postman 1985, 83-84).

I would argue that as part of the development of techno-cultural environments, the rules of *hybrid energy* and *rear view mirror* also apply to the *body machine* metaphor and the perception of the body. Let me explain this assertion using examples and notes on the transformations from one techno-cultural order to another.

Notes on the Hybrid Development of the Organic Order

According to the technological approaches, the transformation from oral culture into script culture has far-reaching consequences. Significant cracks in the organic world appeared with the development of the phonetic alphabet in ancient Greece. The Greeks developed a new mode of perception through the phonetic alphabet. The new medium broke down ideas, sentences, words and semantic meanings through abstract bits of sound (consonants and vowels) which are reduced to abstract visual signs. According to this technique, meaning is constructed by connecting the abstract signs in a linear fashion, step-by-step. Preliterate societies were characterized by situational/contextual thinking, mimesis, holistic approach, and by other

characteristics that were modified, devalued and vanished in literate and highly-literate societies. A new set of values and techniques was created in literate and highly-literate societies: detachment, rationality, objectivity, abstraction, linear argumentation/formal logic, and analytic approach based on fragmentation and reduction (see, for example, McLuhan and McLuhan 1988; McLuhan 1964; McLuhan 1962; Ong 1982; Havelock 1963; Goody 1990; Goody and Watt 1968).

The preliterate experienced and perceived the body in an entirely different way compared to the literate. As Eric Havelock, one of McLuhan's colleagues, argued: the formation of a solid *psyche*, i.e. an autonomous *rational* personality, by Plato and Aristotle, was a key element in the transformation from oral culture into script culture. Plato rejected the preliterate polyphonic and polymorphic self, the collective psyche and mind. The metamorphic identification with different people, objects and situations through the oral technique of mimesis did not coincide with the construction of a rational and solid self who can detach from and analyze the object of study. Script culture headed by Plato had replaced the *poetic* or *oral* state of mind with rationalistic, abstract, analytic state of mind. The medium of the phonetic alphabet enabled the reader to try and neutralize the emotional identification which was rooted in the oral tradition and in the technique of mimesis. Plato urged the literates to separate themselves from the issues and objects through analysis, examination and reexamination. Eventually mimesis had given way to dialectic. Paradoxically the phonetic alphabet which freed the Greeks from the oral culture was assimilated through the technique of mimesis, i.e. through a hybrid process. In practice, the alphabetic *revolution* was a gradual process that developed over a few centuries (Havelock 1963, 45-47, 197-214; McLuhan and McLuhan 1988, 13-33).

The *psyche* is a good example of the hybrid transformation of perception. Indeed, as Havelock maintains, the *psyche* in the Platonic view and in the view of his successors disconnected from the preliterate perception. Yet, I would like to emphasize that the notion of *psyche* in the Platonic and Aristotelian views still pertained to the organic framework (essence and holism) and was far from the mechanistic framework. This observation corresponds to the distinction made by McLuhan between the earlier phase and the advanced phase of *visual space*: the earlier phase was script culture based on the phonetic alphabet (*the genesis of visual space*), and the advanced phase was print culture or the highly-literate industrial society (*visual space in use*). The Platonic *psyche* was *rational*, *solid* and *analytic*, but, at the same time, it also reflected the old perception. For example, in Plato's book, *Phaedrus*, Socrates declares that one cannot understand the nature of the *soul* without understanding the "nature of the whole" or the "nature of the world as a whole". Phaedrus replies that if Hippocrates is right one could not understand the nature of the body without understanding the nature of the whole (Plato, *Phaedrus*, 1995, 71). The Aristotelian view, as well, remained in the organic framework. The *psyche* was defined by Aristotle as a non-spiritual soul which is characterized by essence, wholeness and purpose. According to Aristotle, the *psyche* is both the formal cause and the final cause of the living being, i.e., its holistic essence and its purpose (Aristotle, *On the Soul* and *Parts of Animals*, 1985, vol. 1, 402a – 435b, 640b – 641a).

The impact of early mechanical development was evident in the Aristotelian view. In *Movements of Animals* Aristotle explained the movements of the body as movements of an automatic *puppet*: when the strings are released, the pegs strike against one

another. In the same way, Aristotle described the movements of the body as a *toy wagon* mounted by a child: the bones are like the pegs or iron of the machine and the tendons are like the strings of the machine. Yet animal parts differ from mechanical instruments, because they are characterized by changes of quality and flexibility which are missing in mechanical instruments: animal parts can become smaller or larger, change their form, and increase by warmth and contract by cold. These movements and change of qualities are regulated by imaginations, sensations and ideas, i.e., by the *soul*/*psyche*. Therefore Aristotle wonders in *On the Soul* whether the psyche can be regarded as the actuality of the body, just as "the sailor is the actuality of the ship" (Aristotle, *On the Soul* and *Movement of Animals*, 1985, vol.1, 412b – 413a, 701b).

The analytic tendency that developed in script culture left its mark on the humoral approach. If Hippocrates and even Aristotle had still emphasized the totality of living beings, in the work of Galen one can already detect the analytic tendency. Indeed Galen's perception belonged to the organic world, but it was already very far from the *primitive* perception. Galen was partially biased towards fragmentation. He divided the body into a collection of particular activities. In Galen's program all different parts of the body had to be studied separately, because each of them contains a unique faculty adapted to a specific activity, e.g., the veins contain a faculty for producing blood and the heart contains a faculty for producing pulses. Consequently, in many respects the totality of the living being and the essential force that regulated its activity were decomposed and replaced by the autonomous activities of organs. A fundamental metaphor that shaped the perception of the body already in the pre-modern world defined the organs as *instruments*. Similar to Aristotle, Galen argued

that the organs/instruments of the body may work mechanically. Nevertheless it is important to emphasize again that the pre-modern thinkers, i.e., Aristotle, Galen and their followers, squeezed this conviction into the organic framework. Galen believed that the body was designed by a divine craftsman as an instrument of the soul: the body is adapted to the needs and characters of the soul that controls it. Thus, for example, a species of brave animals must have a different body type in comparison with a species of coward animals. Nature, in Galen's view, always *strives* to protect and to cure the body: when the body is injured, nature works in order to heal the wound. Additionally, according to this view, a *formative* teleological faculty is responsible to the development of the body. Galen compared the matter from which the body is made to the wood from which the ship is built, and the formative faculty to the highest and the most creative art form (Galen, *On the Natural Faculti*es, 1952, 3, 17-27; Temkin 1977, 271-279; Roger 1997, 41-62).[10] According to Galen, the formative faculty is –

"…doing everything for some purpose, so that there is nothing ineffective or superfluous, or capable of being better disposed" (Galen, *On the Natural Faculties*, 1952, 25-27).

Notes on the Hybrid Development of the Mechanistic Order

The symbol of the mechanical world was the mechanical clock. Yet, according to McLuhan and his school, the movable type, which was invented by Johannes Gutenberg around the mid 15th century, laid the foundation of the industrial age. Print culture diffused, enhanced, extended and modified the social and psychological effects of the phonetic alphabet. Furthermore, the printing press was the first assembly line that enabled the mass production of uniform products (McLuhan 1962; 1964). Print was the ground on which modern scientific communities were established from two main aspects: (a) the rapid and efficient diffusion of knowledge (b) the mass production of uniform texts, tables, charts, calculations and formulas, drawings and illustrations, maps, textbooks and journals (Eisenstein 1979, Vol. 2). Psychologically, print creates a strong sense of closure, or finalization, through endless identical copies. In comparison with oral culture, and even to script culture, the printed textbook was less discursive and it tended to present facts rather than proverbs, disputations, personal reflections and comments, interpretations and reinterpretations. Already during the 16th century the French humanist and educationalist Peter Ramus created the paradigm of the printed textbooks. The mechanistic mentality thrived on the printed text. Analytic fragmentation of each subject and specialization of fields of knowledge defined the Ramist program (Ong 1982, 117-135; Ong 1958).

The mechanistic order in the life sciences can be divided into two main phases: the first mechanistic phase, or the early mechanical approach, and the second mechanistic

phase, or the industrial-chemical program. The differences between the phases are shown in table 2. Although its roots can be found in the 16th century, the first phase became dominant in the 17th century. Accumulation of failures and decline of the first phase can be traced to the second half of the 18th century. The first phase was replaced by a second phase, the industrial–chemical phase that reinforced the characteristics of the mechanistic order. Vitalism had become more mechanistic and prominent vitalists at the beginning of the 19th century became the pioneers of the second phase.[11] The second phase lasted from the end of the 18th century until the beginning of the 20th century and it became dominant around 1840.

A clear cut between the two phases cannot be identified, because techno-cultural environments, as well as human perception, thought and ideas, develop in hybrid manner. Like in a wave model, the two phases partially overlap. One can identify a pattern of development which was based on the formation of hybrids between the mechanical and the organic (the first phase), and also the gradual increase in the power of the mechanistic perception and its triumph over the organic perception (the second phase). This pattern is repeated with regards to different aspects in the study of the body and in different fields of the life sciences.

TABLE 2

The First Mechanistic Phase vs. the Second Mechanistic Phase

The First Mechanistic Phase: **Early Mechanism**	**The Second Mechanistic Phase:** **The Industrial-Chemical Program**
Period: 16th - 18th centuries. The first phase became dominant in the 17th century. Accumulation of failures and decline at the second half of the 18th century.	**Period:** from the end of the 18th century until the beginning of the 20th century. The second phase became dominant around 1840.
Organo-mechanical solutions: - The Cartesian solution: a *body machine* and a *soul* - The solution of the Christian mechanists: pre-existence, i.e., the idea that the perfect design of the *body machine* can only be explained as an act of the *Supreme Artificer* who created the organized rudiments of all future embryos. The embryos develop to an adult form by mechanical enlargement and unfolding	**Industrial-chemical program:** - Application of industrial-chemical methods, specialization of research and adoption of patterns of activity of the industrial world - Using only material forces - Final cause as an end state of a series of efficient causes

- The vitalistic solution: a machine regulated by vital forces	- Prominent vitalists became the pioneers of the second phase at the beginning of the 19th century - Vitalism becomes much more mechanistic, until it lost its power when the second phase became dominant.
Prominent representatives of the first phase: Rene Descartes, Herman Boerhaave, Albrecht von Haller, Julian Offray de La Mettrie, Lazzaro Spallanzani, Georges Buffon **Prominent vitalists of the first phase:** The school of Montpellier, the school of John Hunter, the school of Johann Blumenbach	**Prominent representatives of the second phase:** Hermann Von Helmholtz, Matthias Schleiden, Theodor Schwann, Rudolf Virchow, Charles Darwin, Ernst Haeckel, Claude Bernard **Prominent vitalists who promoted the second phase at the beginning of the 19th century:** Xavier Bichat and the Paris School, Jöns Berzelius, Friedrich Tiedemann, Henri Milne-Edwards
***The body is an automaton*:** - *The body is a mechanical clock* As Descartes described it, the movements of the body are produced "in the same way in which a watch's movement is produced by the sheer force of its spring and the shape of its wheels" (Descartes 1989 [1649], 27).	***The industrialized body*:** - *The body is an engine* Following the work of Antoine Lavoisier and Pierre Laplace, physiologists, such as Justus von Liebig, Hermann Von Helmholtz, Julius Mayer, Étienne-Jules Marey, perceived and examined the body as a *converting energy machine*; the motivating power of the body became an engine, i.e., an internal power source that converts fuel

"[Man] is to the ape, and to the most intelligent animals, as the planetary pendulum of Huyghens is to a watch of Julien Leroy" (La Mettrie 1961 [1748], 140). - Simple mechanical models, such as *pumps*, *sieves* and *grinding machines* For example, William Harvey defined the circulation of blood as a piece of machinery, in which one wheel gives motion to another in a successive manner, and the heart as a mechanical pump. Physiologists, such as Giovanni Borelli and Herman Boerhaave studied the digestive system as a grinding machine which is aided by chemical processes	into heat and heat into mechanical work. - Specialization and the *division of physiological labor*: Influenced by Adam Smith and the political economy of industrial capitalism, Henri Milne-Edwards and his school defined the simplest animals as a workshop in which every worker performs the same set of tasks. The body of higher animals was defined as a more complicated factory, differentiated in its structures in a way that each part of the body performs a specialized task. "The principle which nature seems to have adopted in the perfecting of animals, is one which has been found to exercise the most beneficial influence over human progress; it is, *the division of labour*" (Milne-Edwards 1863, 189-193). These ideas of *division of labor* and *progress* influenced Charles Darwin and the theory of *natural selection* - The *cell-state* metaphor: during the second phase, the body had become a *state* composed of *citizens*/*individuals* and the state had become an organism composed of cells. "What is an organism? A society of living cells, a tiny well ordered state, with all the accessories - high officials and underlings, servants and masters, the great and the small" (Virchow 1958 [1859], 130).

The first mechanistic phase was characterized by organo-mechanical hybrids. Descartes is the most obvious example of that. For social, moral and philosophical reasons, Descartes refused to reduce the human mind to a machine. The solution was an organo-mechanical hybrid which was based on the idea that the *human body is an automaton* connected through a casual chain to a *soul*. Through the notion of *soul* Descartes prevented from making the human mind part of the *body machine*, although to a large extent the *rational soul* of Descartes articulated the mechanistic order: it was a non-polyphonic entity that operated through fragmentation and abstraction, i.e., through methodic analysis and formal logic. However, the notion of soul still helped Descartes to prevent the complete reduction of humans to no more than mechanical automata. Unlike the mechanical body, the soul, which as an idea belongs to the old organic perception, endows humans with emotions, consciousness and thoughts and with the ability to participate in an open dialogue. Descartes assigned to reason two qualities that allowed him to discern a human from a machine: (1) the ability to react and to participate in intelligent dialogue (2) as opposed to the machine, reason is universal and is adapted to react flexibly in different situations (Descartes 1989 [1649]; 1972 [1664]; 1850 [1637], 98). It had not occurred to him that a machine could possibly acquire the necessary qualities of an intelligent being.

During the first mechanistic phase, the mechanical clock, pumps and other mechanical models inspired the research programs which were developed by mechanists, such as Descartes and Herman Boerhaave. Eventually, during the 18th century, mechanists such as Albrecht von Haller, Rene de Réaumur and Lazzaro Spallanzani realized that the *body machine* is not necessarily *mechanical* in a strict

sense, but *mechanistic*. This was the point of collapse of the first mechanistic phase. As Spallanzani explained his belief in -

> ...the sage maxim of Haller, respecting the caution with which we ought to apply mechanical principles to the animated system; for, in fact, if the animal machine be strictly subject to Hydraulic laws, why do they not produce the same effects in the vascular system as in common tubes. Whilst, however, we acknowledge that these laws must exert an influence upon the phenomena of the circulation, we contend that their power is counterbalanced by opposite causes, inherent in the sanguiferous system (Spallanzani 1801, 260).

Another aspect that characterized the first mechanistic phase was the dominance of organo-mechanical solutions. Since the technological metaphor assumes the existence of an artificer, one of the main problems in the life sciences was to explain the development and organization of the *body machine*. During the first mechanistic phase, the majority of scientists and scholars did not believe that the mechanistic approach in itself can account for the development and organization of the *body machine*. The Christian mechanists, e.g., Boerhaave, Haller, Réaumur and Spallanzani, supported the theory of *pre-existence*, while Blumenbach and his disciples suggested a vitalistic theory of epigenesis (the embryo takes form and develops only after conception) which was based on a *teleo-mechanical* force. Beyond the competition between the two paradigms, both pre-existence and epigenesis pertained to the first mechanistic phase, since both manifested the organo-mechanical struggle.

I would like to give an example of the *rear view mirror* phenomenon exactly in this context. Boerhaave and the Christian mechanists believed that nature is entirely

mechanical. Boerhaave perceived the body as a combination of solid parts that contain fluids and have the functions of *instruments*. According to this view, the *instruments* of the *body machine* include *pillars*, *props*, *cross-beams*, *fences*, *coverings*, *axes*, *wedges*, *levers* and *pullies*, *cords*, *presses* or *bellows*, *sieves*, *pipes*, *conduits*, *receivers*, etc. The functions of these *instruments* "are all performed by *mechanical Laws*, and by them only are intelligible" (Boerhaave, 1766 [1708], vol. 1, 80-95). The medical theory of Boerhaave synthesized iatro-mechanism and iatro-chemistry, but even a devoted mechanist like him could not have escaped the old organic perception, the traditional worldview and its concepts. While Boerhaave was trying to promote a full mechanistic explanation of nature, his view still referred to traditional chemical thought, and thus he squeezed the mechanical outlook into the organic view:

> [There is] between each particle of gold and each particle of royal water a virtue through which they love each other, unite with each other, and cleave to each other reciprocally (Boerhaave cited in Roger 1997, 372).

This small example from Boerhaave is not an exceptional phenomenon, but rather the norm that characterized even the radical materialists in mid 18th century France, who were among the most devoted mechanists of the first phase. The radical materialists, Pierre Maupertuis, Julian Offray de La Mettrie and Denis Diderot, aspired to develop a complete mechanistic account of life. Yet, while they were trying to explain the formation of life, they encountered perceptual and conceptual block. Seemingly, the *body machine* metaphor implied that the body was designed in a purposeful manner by an artificer. The solution of the materialists was based on a *rear view mirror*: they sneaked animism through the back door, discussed it in mechanistic terms and

developed a materialistic version of animism. In this respect, the explanations of 18th century radical materialists for the formation of the *body machine* were often concluded with attributing the properties of life to matter itself: matter became alive and as a result of its activity spontaneous generations appeared. Maupertuis, La Mettrie and Diderot attributed a "dull sensitivity" to matter. As Maupertuis claimed, for example, the uniform, blind law of gravitation cannot explain the arrangement of parts in the living body. His solution to this problem was based on a principle of sensitivity which was ascribed to organic matter: the living elements comprising the embryo have similar properties to "desire", "aversion" and "memory" which enable them to find their place in the developing body (Maupertuis 1966 [1745]; La Mettrie 1961 [1748]; Diderot 1966 [1751], 31-39; Bowler 2003, 54, 81-84; Roger 1997, 390-392; Foucault 1970, 153-154).

Notes on the Hybrid Development of the Electronic Order

As McLuhan observed, the "peculiar drama" of the 20th century was living in an environment which is both mechanical and electronic (McLuhan 1964, 52-55, 342). Notice that over time the electro-mechanical hybrids are becoming more electronic and less mechanical. One can see it, for example, in the evolution from the gramophone, the tape and the record, through the digital compact disc and to the virtual computer file which is an information that can be uploaded to and download from the virtual space of the internet. In the same way, the technology of mechanical hard discs evolved to the technology of flash memory and SSD. Correspondingly, industrialization and its impact on biology peaked in the 20th century, but when the

electronic-cybernetic environment developed in the 20th century, the mechanistic approach was undermined and the *body machine* took a new form. The new electronic environment even revived, in a new form, *organic* characteristics, such as holism and teleology. Thus, from a historical perspective, the *industrialized body* is a manifestation of a techno-cultural order that is slowly fading away.

The roots of the electronic order in the life sciences can be traced to the early decades of the 20th century. The first post-mechanistic paradigm, *field* theory or the new *organicism*, began to develop in the 1910s (Haraway 1976; Gilbert et al. 1996). During the 1920s Walter Cannon developed the theory of *homeostasis* (Cannon 1967 [1932]), and during the 1930s Hans Selye developed the theory of *stress* (Selye 1936; 1978). One can identify new currents in the life sciences, which appeared during the 1940s and 1950s with the development of the cybernetic-computerized environment. The characteristics of electronic systems and the computer are manifested in the new *body machine*. For instance, the metaphor of the *"genetic code"* translates the body into an *information* pattern. Norbert Wiener (1948; 1954), Ludwig von Bertalanffy (1971), Jacques Monod and François Jacob (Monod 1971; Jacob 1973) were among the prominent representatives of the new approach. The idea of *teleology* was retrieved on the new technological ground. In 1943, Norbert Wiener, the physiologist Arturo Rosenblueth, and cyberneticist and computer engineer Julian Bigelow, introduced a new definition of *teleology*. According to the new cybernetic approach, *teleology* is a behavior directed to a goal which is achieved through a mechanism of negative feedback. In this respect, the "broad classes of behavior are the same in machines [servomechanisms or cybernetic machines] and in living organisms." It should be noted that Rosenblueth worked with Walter Cannon who developed the

theory of homeostasis. The cybernetic approach united the *negative feedback* and *homeostasis* under the *"teleological principle"* (Rosenblueth et al. 1943; Wiener 1954, 95-96).

The biologist Ludwig Von Bertalanffy, one of the fathers of systems theory, summarized the development of the *body machine* metaphor, from the early mechanical age, through the industrial age, and to the electronic age, as follows:

> One such model has been used since the beginnings of modern science. This is the model of the living machine. Depending on the state of the art, the model has found different interpretations. When, in the seventeenth century, Descartes introduced the concept of the animal as a machine, only *mechanical machines* existed. Hence the animal was a complicated clockwork. Borelli, Harvey and other so-called iatro-physicists explained the functions of muscles, of the heart, etc., by mechanical principles of levers, pumps and the like. One can still see this in opera, when in the *Tales of Hoffman* the beautiful Olympia turns out to be an artfully constructed doll, an automaton as it was called at the time. Later, the steam engine and thermodynamics were introduced, which led to the organism being conceived as a *heat engine*, a notion which lead[s] to caloric calculations and other things. However, the organism is not a heat engine, transforming the energy of fuel into heat and then into mechanical energy. Rather it is a *chemodynamic machine*, directly transforming the energy of fuel into effective work, a fact on which, for example, the theory of muscle action is based. Lately, self regulating machines came to the fore, such as thermostats, missiles aiming at a target and the servomechanisms of modern technology. So the organism became a *cybernetic machine*, explanatory of many homeostatic and related phenomena. The most recent development is in terms of *molecular machines*. When one talks about the 'mill' of the Krebs cycle of oxidation or about the mitochondria as 'power plant' of the cell, it means that machine like structures at the molecular level determine the order of enzyme reactions; similarly, it is a micromachine which transforms or translates the genetic code of DNA of the chromosomes into specific proteins and eventually into a complex organism (Bertalanffy 1971, 147).

In light of the influence of the mechanistic tradition, the direction of the *rear view mirrors* in biology had changed. If early mechanists, and even the radical materialists in the 18th century, occasionally squeezed the mechanistic perception into the residues of the organic perception, today the *rear view mirrors* work in an opposite direction. Since the mechanistic perception became part of the *common sense*, contemporary biologists have been trying to squeeze the new electronic perception into the old mechanistic outlook, i.e., to discuss the mechanistic order using the new terms of cybernetics and computerized systems. The approach of Richard Dawkins is a good example of that. When Dawkins discusses *The Selfish Gene* (1976) in digital terms, he squeezes the electronic order into the industrial program of genetic reductionism and neo-Darwinism. In other words, he perceives the new *body machine* through the rear view mirror. The following passage from *The Blind Watchmaker* of Dawkins clearly expresses this view:

> It is raining DNA outside…it is the DNA that matters... The whole performance, cotton wool, catkins, tree and all, is in aid of one thing and one thing only, the spreading of DNA around the countryside… It is raining instructions out there; it's raining programs; it's raining tree-growing, fluff-spreading, algorithms. That is not a metaphor, it is the plain truth. It couldn't be any plainer if it were raining floppy discs (Dawkins 2000 [1986], 135).

In the simulation culture, information, codes and algorithms have become the essence of the organism. Yet, behind the cybernetic-computerized metaphor of the *virtual body* still stand the industrial views of heredity which began to develop during the second mechanistic phase by scientists, such as Gregor Mendel, Charles Darwin, Francis Galton and August Weismann (Mendel 1966 [1866]; Darwin 1868, vol. 2, 357-404; Galton 1962 [1869]; Weismann 1893). Genetic reductionism emphasizes the

action of discrete genes. This approach is in conflict with the antireductionist models of the electronic world, e.g. *feedback mechanisms*, *systems theory* and *holism* or *total field*. From a systemic point of view, there is an experiential failure in Dawkins's metaphor. Computer programs can replicate themselves with feedback from the hardware (i.e., *the body*) and in the future with 3D printing technology they will be able to replicate computers, but computer programs cannot replicate computers by themselves. Thus the *filtering lenses* of Dawkins's metaphor hide the complex interdependence and feedback between all parts of the system. Dawkins was able to do so because following the mechanistic tradition and the principle of fragmentation he separates the issue of heredity from the issue of development. However, the new developmental biology is gradually becoming more electronic and holistic and less mechanistic. Genes, according to the new epigenetic approach, do not have effects of their own, since their actions and regulation depend on complex interaction and *feedback* of many factors: the genome, the systems of proteins which are found in the egg cell and in the organism and environmental factors. Evolutionary biology, as well, is becoming less mechanistic and more electronic. Thus, the threat the representatives of the new paradigm of *Evo-Devo* made in regard to the old paradigm of neo-Darwinism should be taken seriously:

> Population genetics is destined to change if it is not to become as irrelevant to evolution as Newtonian mechanics is to contemporary physics (Gilbert et al. 1996, 368).[12]

The Metaphoric Body in the Total Field of Knowledge

In comparison with abstract modernist views (e.g., positivism or naïve realism), the postmodernist approaches (e.g., the thesis of the *Metaphoric Body*) recognize the significance of metaphors in human thought and they are able to better deal with two major aspects of scientific development: (a) the *extra-scientific* impact of techno-cultural environments on scientific theories and on the assumptions and expectations of scientists (b) the historical dynamics of science, that is, the relative success of contradicting theories in explaining a certain subject and the constant appearance of anomalies and deficiencies which undermine the validity of these theories until they collapse and are replaced by new theories.

The complex relationship between the life sciences and techno-culture is part of the *total field* of knowledge. Despite the gaps between different fields of knowledge and disciplines, the phenomena and explanations in each field are circularly connected to the phenomena and explanations in the other fields. Thus the thesis of the *Metaphoric Body* itself is part of the field. The holistic metaphor of the *total field*, which shaped the perception of intellectuals, such as McLuhan (1964, 47) and W.V. Quine (1961, 42), pertains to the electronic order. The thesis of the *Metaphoric Body* is based on the ideas of McLuhan and therefore it is shaped by the electronic order. In other words, the thesis analyzes the relationship between science, technology and culture, but at the same time it is influenced by them. For example, the ideas of McLuhan on the connection between the electronic technology and the nervous system were inspired by the neurophysiologist J. Z. Young (1951), one of the participants in the Macy conferences in which the cybernetic program developed. In fact, already in the second half of the 19th century, biologists of the second mechanistic phase, such as Emil

Dubois Reymond and Thomas Huxley, or the author Samuel Butler who was influenced by Darwin, contributed to development of the view that technologies are *extensions* of the body, including the idea that the *telegraph is an extension of the nervous system*. Furthermore, McLuhan's theory of media was directly influenced by Hans Selye's theory of *stress* which he saw as a prominent example of the electronic perception. The theory of stress, of course, can be analyzed by the thesis of the *Metaphoric Body*.

This endless circularity of knowledge and the complex interdependence of all fields of knowledge are also manifested in the general relationship between the life sciences and theories of metaphor. On the one hand, the thesis of the *Metaphoric Body* relies on theories of metaphor in order to analyze the relationship between technology and the body and the perception of the body in the life sciences. On the other hand, theories of metaphor themselves rely, among other things, on brain studies, cognitive sciences, neurobiological evidence and models of artificial intelligence.[13]

As a *postmodernist* theory, the thesis of the *Metaphoric Body* is based on the rejection of the objectivist view as well as on the rejection of a clear dichotomy between the *social* and the *natural*. Science is part of a *total field* in which social, cultural, scientific and technological factors influence one another. According to the thesis, metaphors shape all forms of human knowledge and therefore we should recognize their importance. Nonetheless, we cannot ignore that metaphorical fertility has its price. The electronic, postmodern world developed from the modern world and thus one can identify the impact of critical modernist approaches on postmodernist approaches. In this respect, the thesis of the *Metaphoric Body* rather than adopting a

naïve, uncritical approach to metaphors, recognizes the limitations and epistemic problems arising from the metaphorical thinking, which cannot be defined as *objective* and *literal*. Contrary to modern objectivist views, the thesis contends that metaphors are not false assertions by definition or verbal ornaments which can be reduced to literal assertions. Metaphorical frameworks depend on experiential basis, as well as on techno-cultural context. On the one hand, metaphors can be tested empirically and thus they are not necessarily arbitrary, meaningless or false. On the other hand, we should not be misled by their fruitfulness and their successes and identify them as *objective literal* truths.

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NOTES

[1] According to the psychological studies of Robert Verbrugge, the domains of the metaphor tend to appear together in a single imaginary event and as a result transformations occur within the domains. This phenomenon was documented while participants were asked to describe their experiences in response to metaphorical statements. For instance, while thinking about a skyscraper as a giraffe and vice versa, people reported they imagine a building which "became very skinny and developed spots", or a giraffe with a building shape body running in the jungle (Verbrugge 1980, 110-120). Blending theory, as well, emphasizes the fusion of elements from different domains within metaphorical situations. Mental spaces, according to this theory, represent particular scenarios of given domains. The blend space fuses information, structures and scenarios from two input spaces or more (Fauconnier and Turner 1998; Grady et al. 1999; Coulson and Matlock 2001; Coulson 2001; Fauconnier and Turner 2002).

[2] Henning Lederer, 2011, *Man as Industrial Palace* <http://vimeo.com/6505158>

[3] Tools and technologies amplify and extend the abilities of organs and bodily functions. According to Hans Hass, their main advantages are as follows: (a) They have no need of constant nourishment, thus saving energy (b) They can be discarded or stored rather than carried (a further saving of energy) (c) They are exchangeable, enabling man to specialize and to play multiple roles: when carrying a spear, he can be a hunter, or with a paddle he can move across sea (d) All of these instruments can be shared communally (e) They can be made in the community by 'specialists' (giving rise to handicrafts) (Hass 1970, 103-104; cited in McLuhan & McLuhan 1988, 95). Despite the advantages, McLuhan also identifies the dangers of the interaction between *Man* and his extensions. He argues that (a) people tend to become servomechanisms of the technological environment they use (b) people are usually not aware of how the technological environment reshapes them. The response to the technological shock is *numbness*/*narcosis*/*closure*/*amputation* that is imposed on our perception and consciousness (McLuhan

1964, chap. 4 and chap. 7). McLuhan and McLuhan also refer to the ideas of A. Simeons, K. Storr and D. Lorenz - concerning the dangers of technology (McLuhan & McLuhan 1988, 95-96).

[4] According to Searle, computer programs, unlike the brain, do not attach meaning to symbols, and thus a formal-syntactic manipulation of symbols using a computer program is not a sufficient condition for the creation of semantics, mind and consciousness. Searle's argument is based on a thought experiment or an allegory in which a system that manipulates symbols becomes a *Chinese room*. Against Searle's argument, the Churhlands suggest the *luminous room* argument. In this context it is interesting to note that McLuhan believed that a precondition for simulating consciousness is the creation of a *total field*. The problem with computers today, he noted, is that "…they are highly specialized" (McLuhan 1964, 351).

[6] Automata are extensions of bodily functions and in this respect the cybernetic feedback is no exception. Thanks to the cybernetic principle the user can perform different tasks simultaneously and leave the machines without any physical supervision of his body. The tasks are controlled by an extension of a remote body or a remote user who can perform other activities. Thus, if the cybernetic feedback is an extension and amplification of the mental-manual control, and if the electronic medium can extend and amplify the nervous system, then the electro-cybernetic technology creates very efficient extensions of bodily functions that integrate the neural and the manual.

[6] McLuhan was highly influenced by James Joyce and in one of his books he identified ten major periods in the history of Western culture (from the Paleolithic age to the age of television), which correspond to the ten thunders in *Finnegans Wake* (McLuhan & Fiore 1968, 46-48).

[7] See also Gordon Gow's (2004) analysis of *acoustic space* and *visual space* as spatial metaphors.

[8] McLuhan borrowed the term *implosion* from Lewis Mumford who had discussed the immigration of different ethnic groups to the US (Lash 2002, 187).

[9] I will use the term *Organic* (in a different sense than the term *organicism* in modern biology) as a generic name that represents ancient and pre-industrial perceptions, traditions and values. The terms *organic* and *mechanical* correspond to the McLuhanite notions of *acoustic space* and *visual space*, as were previously defined. *Visual space* is the environment that began to develop with the invention of the phonetic alphabet. This environment became dominant by print culture, mechanical inventions and the industrial society. *Acoustic space* is the environment of oral cultures. McLuhan often uses expressions such as "organic wholeness" and "complex, organic interplay of spaces" in relation to the *acoustic space*. Similarly, he refers to the post-industrial, electronic age as "not mechanical but organic", since the electronic age retrieves, on a new ground, elements of pre-modern *acoustic space* (McLuhan 1962: 31, 45, 135).

[10] As a citizen of the Roman Empire, Galen adopted the maxim "To each his own", which articulated the social order of the Romans. The meaning of this phrase is that each person is entitled to a share according to his rank. Galen thought that nature works according to the same principle of justice: the size of each organ in the body depends on the purpose which it serves; the number of nerve fibers in each part of the body depends on the sensitivity that is needed for its function, and so on. The *social organization* of the body was also manifested in other aspects. Galen, for instance, imagined the body as a city in which the chyle is carried by vessels to the liver, just as food is transported to the bakeries through many routes. He attributed growth and nutrition to the nature (*physis*) of plants and animals. On the other hand, he attributed feeling and voluntary motion to the *animal soul* (the *psyche*). Galen remarked that some make a distinction between the *vegetative soul* and the *sensory soul*: plants are governed by the *vegetative soul*, while animals by the combination of the two souls. This view, explained Galen, is not different from his own view, although it contains inaccurate concepts (Temkin 1977, 271-279; Galen, *On the Natural Faculti*es, 1952, 3, 17-27).

[11] Xavier Bichat and the Paris School of Medicine are the best example of vitalists who were among the pioneers of the second phase. The fragmentation of diseases was one of the major implications of the mechanical metaphor and the mechanistic-reductionist approach in physiology: if physiological processes are not based on holistic forces, but on mechanistic forces and distinct mechanisms within the *body machine*, then the malfunctions and diseases of this machine are located in specific

mechanisms. Although the members of the Paris School believed that the body is much more than a mechanical automaton, they decomposed it through the mechanistic approach. Bichat and his colleagues were convinced that diseases are malfunctions which can be located in specific parts of the *body machine*, i.e., specific tissues (Bichat 1813 [1799]; Corvisart 1962 [1806]; Laennec 1979 [1821]). In this respect, they were much more radical than the mechanists who preceded them and influenced their research program (Haller 1756; Morgagni 1983 [1761]). The program of the members of the Paris school was an integral part of the trends of industrial society. Their research program and goals were shaped by the characteristics and needs of industrial society. The new science of pathology was part of the bureaucratic-medical surveillance on populations, that is, part of the systemic-analytic program of the modern industrial state (Foucault 1973). Even the new form of organization in the hospitals of Paris resembled the organization in the factories that were described by Adam Smith in the 18th century. This new form of organization was based on fragmentation, specialization and standardization. See the description of the English Dr. John Forbes, who lived in that age (Forbes in Laennec 1979 [1821], vii-ix).

[12] Richard Lewontin and Stephen Gould are among the prominent biologists who in the last decades criticized the reductionist models in genetics and evolution and promoted alternative views (Lewontin 2000; Gould and Lewontin 1979). Field models, computers and cybernetic systems influence the new developmental biology. See, for example, the review and theoretical analysis of Gilbert et al. (1996), Jablonka (2004) and Jablonka and Lamb (2005), and the historical analyses of Fox Keller (2002; 2000) and Doyle (1997).

[13] For example, Seana Coulson and Teenie Matlock, argue that empirical data concerning "event related brain potential" (ERP) suggest that the same brain regions are involved in the construction of both literal and metaphorical meanings. Despite the differences between the creation of literal meanings and the creation of metaphorical meanings, in certain respects there is continuity between them. Similar processing appears in the comprehension of both literal and metaphorical meanings: space structuring, mapping and blending (Coulson and Matlock 2001). Alternatively, McLuhan and McLuhan (1988, chap. 2) suggest that the differences between the metaphorical and the literal correspond to the differences between the right and the left hemispheres of the brain. The equilibrium

of the hemispheres is dynamic. The literal perception is characterized as analytic, linear and continuous (a bias towards the left hemisphere), while the metaphorical perception is characterized as contextual, resonant and discontinuous (a bias towards the right hemisphere). On metaphors, brain studies and cognitive sciences see also: Coulson 2001; Kövecses 2005, chap. 2. On metaphors and models of artificial intelligence see, for example, Barnden et al. 2004.