On the traces of Hephaestus

Skills, technology and social participation

By Guido NICOLOSI

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I dedicate this book to Urbana and Riccardo Jr.. They are our future and hope.

Chapter 1

Introduction

Technology is neither good nor bad; nor is it neutral.

(Kranzberg' s first law of technology)[1]

This work has developed within the on-going scientific and socio-political debate on the issue of the relationship between technology and society. In common understanding, and also in scientific practice, these are very often viewed as two distinct and quite separate entities. Against that, this study presents a theoretical exploration aimed at showing that there are significant margins within which to maneuver in order to recuperate and valorize human and social action in the sphere of technological development. The principle of interwovenness between technology and society has been an important contribution of the sociology of science and technology. It has enabled what in sociological terms is usually referred to as the debate on the 'social construction of technology'. This issue, therefore, is not new or original, but rather a major and ongoing debate that has characterized social studies of science and technology (STS studies) for some forty years on. Thus, the 'interwovenness' principle seems to be broadly accepted nowadays in humanities and social sciences. Nevertheless, if one looks at the way in which technology is developed by engineers and technicians and applied in policy (sometimes also by sociologists and philosophers) – that is the *practice* science and technology development -of it seems that this principle may indeed formally recognized within one field but substantially denied or misunderstood in another.

It is important to emphasize that although STS studies have been able to express this interwovenness, the politico-economic (differentiating) aspects of technology development have tended to be neglected. They have been deeply elaborated, but in a rather essentialist and determinist way (as I will discuss in Chapter 2). For this reason, I think, a critical

[1] Kranzberg, 1986.

reflection on the issue of the interwovenness remains important; in particular, it is necessary to explore the margins of human and social action in the technology of today. One objective of this thesis, therefore, is to make a contribution to the actual interwovenness debate, indicating that a new cultural horizon is needed to reflect critically on technology-society interaction, especially on the relationship between human experiences and technology design.

This new cultural horizon is explored by analysis of the role human experience plays in technical action. This focusing on human experience is directly inspired by Andrew Feenberg's teachings on technology. In supporting his thesis of the possibility of a democratic rationalization of technology, Feenberg aims to develop Marcuse's argument of the need to reconcile the rationality implied by science and technology with experience of the *lifeworld*.[2] For Feenberg, science and technology should also be constrained by values and human needs recognized in experience and validated in political debate. In this, Feenberg seems to be recovering the phenomenological approach of Gadamer and Merlau-Ponty who, while not wanting to endorse an impossible and regressive re-enchantment of nature, did want to defend the role of experience against the naturalistic reductionism of science and technology in modern society (Feenberg, 2010: 208-10). It is clear that demonstrating the possibility of reconciling experience and technology means opening significant margins within which to maneuver in order to recuperate and valorize human and social action within the sphere of technological development, democratic participation and potentialities included (as considered in Chapter 2).

Thus, the main area of critical reflection in this thesis is on 'human experience and technology'. The reflection is guided by the following key issue: Have technology and human experience really become two mutually exclusive entities? This theoretical question will be discussed from various perspectives, developing a socio-anthropological and socio-epistemological research that proceeds from a specific social *unit of observation*, that of *skills*.

[2] Lifeworld (*Lebenswelt*) represents a condition in which the world is experienced and lived. It may be conceived as a universe of what is self-evident or given, a world that subjects may experience together. Sociologically, it introduces the socio-cultural context wherein what seems immutable (for example, tradition, common sense, social practices) is, in reality, historically mutable. For Husserl, the lifeworld is the fundamental of all epistemological enquiries.

1.1 The concept of experience and research methodology

1.1.2 Skills, lifeworld and the sociality of technical action

In taking skills as the specific unit of observation of this work, I am obliged to underline that the main object of this thesis is *not* skills. I do not want to develop a research model or paradigm for skills. Rather, I will 'use' this category in an 'instrumental' way, employing skills as the main indicator of a more general dimension of investigation: *experience in technical action*. In order to explain the reason for this choice of instrument, I use a classical conceptual distinction made within the methodology of social research.

In quantitative and qualitative social research, there is a difference between the *unit of observation* and *the unit of analysis*. The former is described by the data one analyses, whereas the latter is the major entity that is being analyzed, the 'what' is being studied. The two should not be confused. A study might, for example, work with a unit of observation that is situated at an individual level but have as the unit of analysis something at a neighbourhood level, and thence drawing conclusions on neighbourhood characteristics from data collected from individuals. In the case of the present work, since it is focused on delivering theoretical insights, the focus is not on collecting empirical or statistical data. Nevertheless, I will collect conceptual data produced by the unit of observation of skills, with the aim of drawing more general theoretical conclusions on the unit of analysis (experience in technical action).

But why skills? In the epistemological point of view of ancient Greek culture, experience was expressed with the word 'ἐμπειρία' which coupled the terms 'ἐν'/ 'ἦν' (inside) with 'πεῖρα' (practice). This meant that with experience, according to ancient Greeks, man was able to essay or practice reality from within. This etymological meaning expressed a vision of knowledge open to personal and social (and also contingent) experience.[3] The scientific revolution of modernity split these two formerly interwoven domains (rationality and experience). Today, in the hegemonic mainstream meanings, ends, practices, traditions, that is *sociality,* are considered as subjective, non-rational, non-scientific, against which there is nature, means, abstraction. No mediation is accepted.

[3] Interestingly, in this ancient philosophical thought, the idea of essence prevailed as the rational form of the teleological structure of everyday life.

This thesis, on the contrary, refers to an idea of experience linked to the concept of *lifeworld*. For this reason, I discuss the *sociality of technical action* and interwovenness of these two domains (rationality and experience). In order to do this, from the methodological point of view, a sort of operationalization[4] process of the concept of 'experience in technical action' is developed (Figure 1).

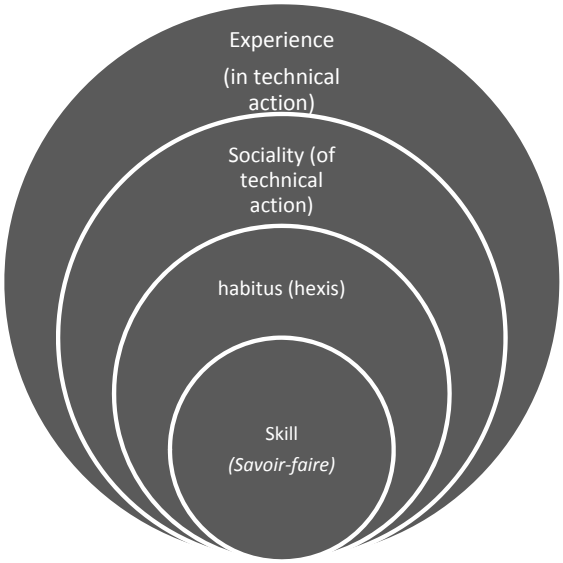

Figure 1: Operationalization process of the concept of 'experience in technical action'

This diagrammatic representation expresses the semantic operationalization of the concept of experience (as referring to technical action). The different rings express the different level of abstraction: the more external the ring, the more general the concept considered. The generality of the concept of the first (outer) ring (experience in technical action) is reduced in the second ring, where what discussion is specified in more concrete terms as social quality (of technical action). Specifying that social quality of technical action suggests analysis in more concrete terms as the classical concept of *habitus* (or *hexis*).[5]

[4] In research design, 'operationalization' is a process defining the measurement of phenomenon that is not directly measureable but whose existence is indicated by other phenomena.

[5] '*Habitus*' is the Latin version of the Greek '*hexis*', an important term in the philosophy of Aristotle, and meaning a set of dispositions that generate practices and perceptions. Roughly, *habitus* is the way we see the world in which we live, through our own personal experiences acting as our eyes. According to Mauss and

This conclude in more operational terms with the analysis of the concept of skill in the final ring, a concept endowed of concrete, visible and measureable social characters.

This operationalization process and the final choice of adopting skills as the main unit of observation is deeply influenced played by the work of the French anthropologist Marcel Mauss. Mauss indicated the existence of an inseparable link between man and technique, affirming that it is the human body that is the first *technical means* we have at our disposal, and that it is this which we must learn to master in order to survive:

> I made, and went on making for several years, the fundamental mistake of thinking that there is technique only when there is an instrument. I had to go back to ancient notions, to the Platonic position on technique, for Plato spoke of a technique of music and in particular of a technique of dance, and extended these notions.[6]

For Mauss, technique is a traditional (social) and efficient (productive) action perceived by the actor as an action of a mechanical, physical or physical-chemical order. The body is the first instrument of man, his first technical object. The primary form of technique is therefore that of the body. Skills are guided by a *habitus*, Pierre Bourdieu's conceptual development from Aristotle's *hexis* indicating an ensemble of culturally transmitted, enduring dispositions, anchored to the human body (Bourdieu, 1980).[7] More recently, François Sigaut (2007) has confirmed this principle of fundamental association between technique and the body, reminding us that the etymological root of the term *organ* (of the body) is the Greek word '*ὄργανον*', meaning 'tool'.

Bourdieu, it is fundamentally a bodily dimension, since *hexis*, a basic dimension of the sense of social orientation, is a practical way of experiencing and expressing one's own sense of social value.

[6]Nous avons fait, et j'ai fait pendant plusieurs années l'erreur fondamentale de ne considérer qu'il y a technique que quand il y a instrument. Il fallait revenir à des notions anciennes, aux données platoniciennes sur la technique, comme Platon parlait d'une technique de la musique et en particulier de la danse, et étendre cette notion (Mauss, 1936 : 9). The English translation of this paragraph is taken from Crary & Kwinter, 1992 (p. 461).

[7] In his *Logic of practices* (1990), Pierre Bourdieu defined habitus as a 'system of durable, transposable dispositions, structured structures predisposed to function as structuring structures, that is, as principles which generate and organize practices and representations that can be objectively adapted to their outcomes without presupposing a conscious aiming at ends or an express mastery of the operations necessary in order to attain them. Objectively "regulated" and "regular" without being in any way the product of obedience to rules, they can be collectively orchestrated without being the product of the organizing action of a conductor' (p. 93).

Here, technique is understood as that which employs tools other than (additional to) the body. It is assumed that it develops from this fundamental relationship, known by terms like 'skill', 'ability' and *savoir-faire*[8], and that it is linked to qualities such as perception, action, intentionality, corporeity and context. These elements will thus reappear frequently during this reflection: analyzing technique, as I see it, means starting off from these. Highlighting the relationship between these phenomena and technique in itself involves a demonstration that technique and society are not separate entities. Indeed, technical skills are not the property of any single body, but are qualities arising from the entire system of relationships that constitutes the presence of an agent in an extensive and structured physical and social environment.

1.1.2 Transdisciplinarity, the encyclopaedic approach and semiosis

But if the interwovenness of technique and society can be easily understood on the basis of these very common and (in sociology) shared evidences, why another work on this issue? As emphasized above, although in sociology the principle of the 'interwovenness of technology and society' is accepted, this principle seems to be somewhat confined to and within that discipline. Moreover, STS studies, which were born as a *field* of interest with a strong interdisciplinary orientation, nowadays seem having acquired a new disciplinary configuration, with its own exclusive borders and gate-keepers (schools, masters, literatures, etc.), with a closed jargon and with a rather poor critical gaze.

There is still a huge lack in interdisciplinary research with the philosophical and sociological debate on this issue apparently remaining within the narrow limits of single disciplines and even research areas (humanities, social sciences). At the same time, interdisciplinary research is itself not always able to overcome the limits of mutual understanding and communication. Interdisciplinarity may easily be – often is, or at least seems to be - a communication between deaf people. The communication is generally simulated for satisfying ministerial requests of bureaucrats and the desire for the display of innovative medals. However, everybody knows that really careers, power and professional

[8]*Savoir-faire* is a form of material understanding applied to tools and enabling the achievement of real tasks. It cannot be abstractly and formally reproduced, since it is incorporated in the bodies of those who possess it. Directly and materially applied to the task and transmitted only through imitation and practice, it is thus different to other modes of knowledge, such as scientific knowledge.

satisfactions are still assured within the reassuring (single) disciplinary borders (publications, journals, committees, appointments, etc.) and suchlike.

It is clear that a new cultural horizon is needed. With this work, I try to suggest that a possible way forward is represented by the idea of trans-disciplinary research. Actually, trans-disciplinary research means that individual researchers should themselves make an effort to overcome disciplinary isolation through their own border crossings in order to emphasize the principle of *the unity in diversity of human knowledge*. This requires a huge effort, however, a passage across inhospitable lands that is certainly difficult and may seem dangerous. Despite these risks which are several - including accusations of and resistance to presumed field invasions, ambitious pretentions, jealousies, criticisms of inevitable oversimplifications, difficulties in managing unknown concepts and terms, reduced margins for empirical research, etc. - trans-disciplinary research is nevertheless a risk worth taking.

From the epistemological perspective, trans-disciplinary research should be based on a particular 'picture' of knowledge. Particularly, trans-disciplinary research assumes knowledge to be a semantic network of meaning that can be hardly organized in a well-structured hierarchy of linear matches. Rather, knowledge is based on an unsteady, precarious and always contextually reconstructable network of semantic associations. This *implies a different methodology of inquiry* – as provided, for example, by the so-called *encyclopaedic approach* which has been widely represented and described by Umberto Eco (1984) in terms of an opposition to the so-called *dictionary-like approach*.

The dictionary informs and defines a particular metaphorical representation of knowledge based on the figure of the so-called Porphyrian tree (*Arbor Porphyriana*), a conceptual device intended to illustrate the 'scale of being' (*scala predicamentalis*) elaborated by the Greek logician and philosopher Porphyry (Figures 2 and 3).

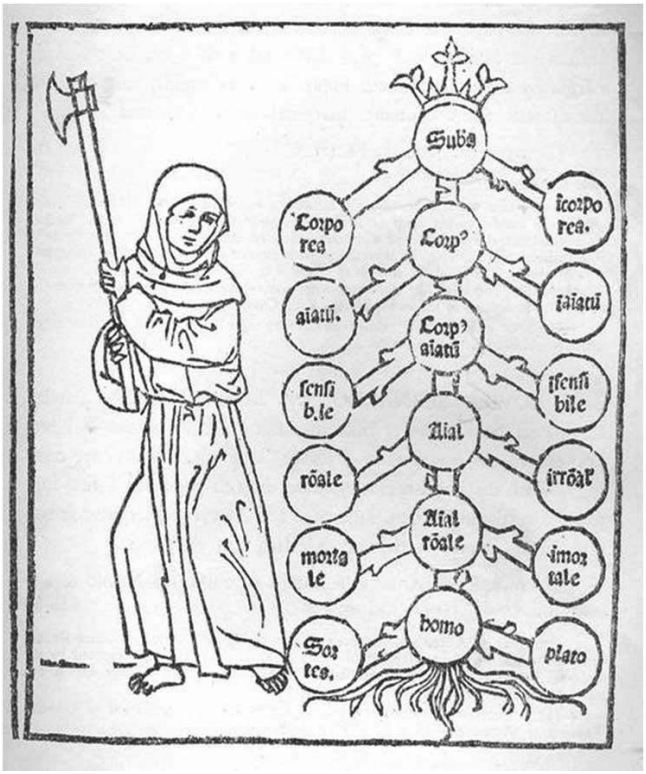

Figure 2: Porphyrian tree (*Arbor Porphyriana*)

Porphyry elaborated this 'device' for presenting the Aristotelian classification system through a tree-like diagram based on dichotomous semantic oppositions. This device is considered the main model of the so-called 'dictionary-like semantics', a classification system implying a 'fall' from 'genus to species', based on a formal, linear and hierarchical system of linkages between categories. This model usually informs the hegemonic methodology of (disciplinary) scientific research.

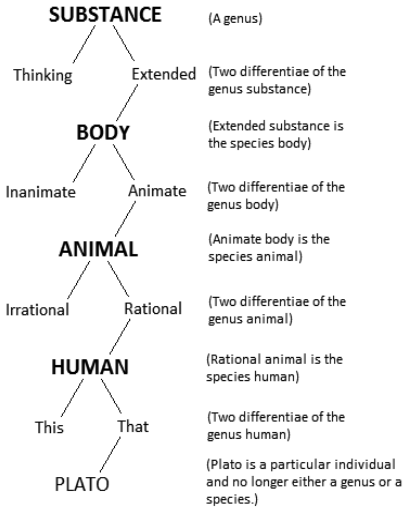

Figure 3: Porphyrian tree

In opposition to this epistemological and semiological model, Umberto Eco presented a new model broadly inspired by Peirce's Theory of Signs (semiotics). Eco speaks of a *dynamic object*, the object itself, which we cannot never fully 'grasp' because we never have a complete, comprehensive and total vision of reality. We can only ever see reality from a certain point of view. This way in which we see things, 'caged' within our cultural system, is the so-called *immediate object.* But anything can be a sign as long as someone interprets it as 'signifying' something, and signs can and must be interpreted. This interpretative process is termed *semiosis* and in Peirce's theory it is considered to be unlimited. Actually, when we meet a 'signifier'[9] – a '*representamen*' in Peircean terms - a process is initiated that leads to our interpretation of the representamen through another sign (Peirce calls this new sign: the '*interpretant*'). This last is another cultural unity useful to interpret, but one that will, in turn, call another interpretant, leading to a series of successive interpretants (potentially) *ad infinitum.*

For this reason, according to Peirce, the meaning of a representation cannot be anything but a representation. Any initial interpretation can be re-interpreted and so *semiosis* is not considered a *structure* but a *process*. In this idea of *semiosis* neither universal semantics nor metalinguistic entities are allowed. Here, the system is based on an indefinite series of

[9] A signifier is the form, not necessarily material, which the sign takes.

content units that are mutually defined and with a different nature but without being hierarchically ordered. These units cannot be classified as essential or ancillary. Eco defines this system an '*encyclopedia*'. Indeed, operationally and occasionally, within this system, local trees of meaning can be isolated. But the system has the complex structure of a *rhizome*, that is a network in which all the points are, more or less, directly connected to each other.

1.1.3 Rhizome semantics

The rhizome is a special kind of root (a subterranean stem of a plant usually found underground) that can penetrate soil due to a horizontal extended movement. In botany, this root is considered as opposite to the usual taproot growing downward vertically and in-depth. It became an important metaphor in philosophy as a result of the work of Deleuze and Guattari (1980). Referring to human knowledge, they opposed it to an arborescent conception of knowledge, which works with dualist categories and binary choices. A rhizome works with planar and trans-species connections, while an arborescent model works with vertical and linear connections (Fig. 4 and 5).

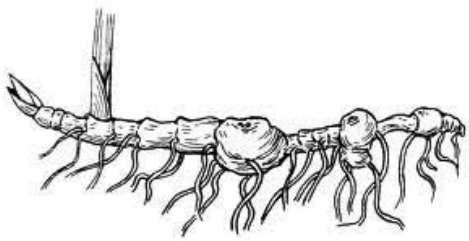

Figure 4: Rhizome

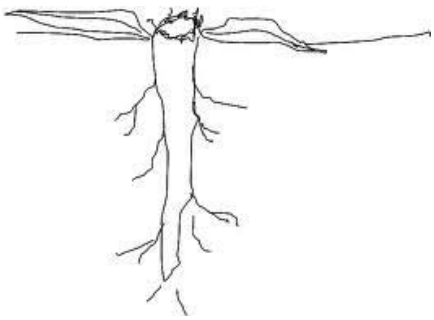

Figure 5: Taproot

The rhizomatic method is particularly interesting. It opposes the idea that knowledge must grow in a tree-like structure from previously accepted ideas. New thinking need not to follow established patterns. It is interesting to notice that, as is clear from Figure 3, the horizontal extension of the root not exclude the possibility of in-depth vertical movement. Using a process of analogical and semantic associations, a rhizomatic method of knowledge can help in creating an intellectual and semantic map whose originality consists just in the coupling of concepts usually kept separate. This is what is attempted in this thesis coupling, for example, *epigenetics* (bio-anthropological dimension) with *technicity* (socio-anthropological dimension) and *open source* (socio-political dimension).

This semantic model is usually rejected because it challenges the myth of *expertise* of a defined and complete set of technical knowledge about a specific issue, idea which is directly linked to the tree-like structure of knowledge.[10] The rhizomatic model of knowledge requires a set of different research techniques reciprocally intertwined. The first technique is to use a language that is both logical and analogical through the use of so-called *nomadic concepts.*[11] For the purpose of this study, the concept thus employed is that of *epigenetics*, which has been already used very fruitfully in robotics.[12] The second technique is anchored to a process of comparing different literatures of different domains. Here, what is original is not the object of analysis in itself, but the process of comparing

[10] What is really bizarre is that this belief is gaining more and more ground also within *humanities*.
[11] Darwin stands as the best example of the potential value of this method with his use of concepts from horticulture for a theory of evolution. Another fruitful example is that of the concept of 'entropy'.
[12] *Epigenetic robotics* is a scientific field studying the developmental architectures allowing open-ended learning of new skills and knowledge in embodied machines. In this approach, robotic 'learning' is cumulative, as in humans, and results from the robot's exploration of the world in combination with social interaction.

issues, concepts and literatures. In this thesis we tried to follow this methods and the three main chapters mirror this methodological effort.

1.2 Problem statement and research questions

While this work deals with the problem of the relationship between technology and society, it does so by developing research firmly grounded in the theme of the role of human experience in technical action. Moreover, it starts from the position that the root problem for any analysis of the so-called technology-society relationship concerns the definition of a specific perspective from which to examine such a relationship. For this reason, the primary objective is to develop this very perspective. Essentially, the aim is to combine a rhizomatic and associative working methodology in a novel fashion, together with a certain theoretical sensibility (outlook) which may be called '*critical-pragmatic*' (Chapter 2).

My hope is that this combination may enable a conceptual map to emerge from three selected access points - bio-anthropological, socio-anthropological, socio-political - which can then highlight and endorse the need to reassess the importance of human praxis in technical action.

The originality of this thesis consists, then, precisely in the associative combination of the elements in the making of this conceptual map, since it is with just this combination, I suggest, that we may express the specific perspective referred to.

In the light of this outline, the key problem of the research is to develop a theoretical perspective by which human experience can be reintegrated in technical action. The core problem is thus to contribute to the development of a new outlook (perspective) in which the role of human experience, praxis and skills in technical action can be re-evaluated, leading to a process of *bottom-up democratization of modern technologies*.

The main problem defining this focus is the possibility of understanding the ways and degree to which technology and experience (in the socio-anthropological and operating

terms defined up to this point) have become two mutually exclusive entities. In order to do this, I will investigate how the primary relationship between body, society and technique has been transformed by the advent of modern technology and what kind of challenges this change implies.

This provides the overarching theme for reflection developed in the next chapters which are guided by the following three 'study questions':

1. What is the bio-anthropological explanation and justification for the importance of experience in human culture? And is there an epistemological paradigm able to represent such link in life sciences today?
2. What kind of socio-anthropological data can help us understand whether and to what extent the relationship between corporeal experience and material reality is still relevant in defining the idea of technicity?
3. Which practices of technological development are in a position to concretely recuperate human skills in the processes of technical innovation? And how can such practices be the advocates for a greater democratization of technology?

Together, these research questions provide a tool with wich to critically investigate the main focus of the work from three different but complementary perspectives of analysis: the bio-anthropological, the socio-anthropological and the socio-political.

1.3 Thesis structure

Chapter 2 presents the theoretical background of this thesis. The main aim is to show that this background has been characterized by the existence of an 'essentialist paradigm', one that traditionally influenced the philosophy and sociology of technique. This, I argue, shaped a dystopian distortion of sociological interpretation of technical action (Section 1) affecting progressive currents of study (Section 3). The second section describes the philosophy of praxis as an antidote to the determinism of the essentialist paradigm outlined in the first. Section 4 presents Andrew Feenberg's thinking as a philosophical vision that is able to rehabilitate Marx's concept of praxis. In addition, this chapter tries to make explicit

the ‘perspective angle’ of this thesis, that is the theoretical gaze and sensibility that influenced him in selecting theories and authors (critical pragmatism).

Addressing the first study question – concerned with a bio-anthropological link for the importance of experience in human culture – Chapter 3 seeks to show that skills are an ineliminable anthropological given since they are bound to the very biological status of humans. In particular, I aim to demonstrate that although scientific culture and public opinion have become dominated by theories with roots in a genocentric cultural paradigm ruled by a determinist “informational” mythology[13]. Against this mythology, a corpus of advanced analyses has developed demonstrating that the human organism is characterized by extraordinary malleability. This corpus may be characterized as constituting an approach that employs what is dubbed the ‘*epigenetic paradigm*’. This paradigm re-evaluates the mutual interchange between organism and environment, rediscovering the active role of the organism in this relationship - and responding to the first study question.

The suggestion developed is that the idea that epigenetics has of the organism scientifically supports a socio-anthropological conception of man as a real *being-in-the-world*, namely an intentional body that lives out a relationship of reciprocity with the surrounding (physical and social) environment. This, therefore, refers to a being ontologically grounded in experience. Indeed, the epigenetic interpretation of man dismantles the informational model and suggests, analogously and *a fortiori*, that in the *cultural dimension* too, the human being must not be considered an organism with an informative code encapsulated in his ‘mind’. The reasoning followed thus uses the epigenetic paradigm in order to challenge informational determinism, both on the biological as well as social level. Essentially, an epigenetic analysis offers scientific support for a socio-anthropological idea of man as a real being-in-the-world, a being that, facing processes of growth, development and also decay, incorporates in his very anatomy (muscles, neurology, etc.) particular skills and habits that lend him a plasticity in respect to the surrounding physical and social conditions.

With chapter 4, I attempt to illustrate that modern technical action (technology) has limited but not eliminated the anthropological and social features at the roots of technique, such as

[13] Conditioned by Cartesian dualism (body/mind, form/substance) this paradigm considers the genetic code (the genome) a set of discrete units of information that govern the human body and behaviour.

perception, action, intentionality, corporeity and contextuality. In attempting to answer the second study question – on socio-anthropological data supporting the relationship between corporeal experience and material reality as still relevant in defining an idea of technicity – I show that in the context of the scientific literature, various (techo)pessimistic readings uphold the principle by which the advent of technology in modern society has provoked a deterioration of the relationship between perception and action and the separation between corporeal experience and material reality. In particular, many assert that the introduction of electronic and digital technologies has caused the loss of skills in exploring the world and the solipsistic closure of the body in a virtual world artificially generated by machines. This chapter criticizes such a reading, presenting an interpretation of an idea of technicity based on the intimate and indissoluble interweaving that exists between organism (body) and environment. In order to do so, technical action is defined in the framework of a model, known as SPIDER (Skilled Practice Involves Developmentally Embodied Responsiveness), based on Tim Ingold's ecological perspective, presenting some points of friction with the ANT (Actor-Network Theory) model of Bruno Latour and colleagues.

Chapter 5 seeks to shed light on the existence of important theoretical and practical margins for a recovery and valorization of social skills in modern technical action that may achieve a greater democratization of technology. The third study question guiding this – related to which practices of technological development may be able to recover human skills during technical innovation and how such practices can support a greater democratization of technology – is addressed through the argument that the valorisation of the role of experience and corporeal skills in the relationship with modern technology does indeed raise the Feenbergian theme related to the possibility of conceiving of a democratization of technology.

In particular, the possibility is explored of considering open source - basically, universal access to and (re)distribution of information, particularly design – as a new, free or non-licensing (commons) model for shared technological development will be explored. Clearly, the demands of critical theory are met here insofar as this is a quintessentially democratic development, and pragmatic in that it is thus open to social practices. In other words, the work open source is asked to do here is to define the institution of a participative method. Through this method, the hegemonic *technical code* of which

Feenberg speaks – 'the realization of an interest or ideology in a technically coherent solution to a problem' (Feenberg, 2005: 52) - is rendered an open entity – a public interest in a socially oriented solution - in which processes can be achieved that constitute and lead not only to novel development but also to a creative appropriation aimed at literally re-inventing technologies. In such penultimate chapter, such principles will be conceptually applied to the controversial and emblematic case of biotechnologies.

The burden of Chapter 6 is to bring together the analyses of the main chapters, setting out the key issues, objectives and concepts discussed in the essay and presenting the main conceptual results in response to the various *research questions* motivating this work. A semantic map is provided. Finally, the main aim is to develop a general discussion to sketches some of the new questions representing other possible proposals for future lines of research.

Chapter 2

Theoretical background.
On technology: essence, praxis, experience[14]

2.1 Introduction

The main aim of this chapter is to present an overview of the theoretical background of the philosophical and sociological debate behind this research. Firstly, I show that the philosophy and sociology of technique have been conditioned and undermined by an essentialist paradigm of analysis. I also show that this paradigm has been fiercely counteracted by two opposed approaches, critical theory and pragmatism, usually considered mutually incompatible. Secondly, I suggest that in order to overcome the limits of these approaches, it is possible to adopt a theoretical gaze able to contemplate their mutual contamination. This contamination is provided by a 'new' philosophical current, 'critical pragmatism', which can inform a renewed idea of the *philosophy of praxis* in order to instigate a constructive lecture of technology. In this work, I do not try to develop this new philosophy of praxis, but rather indicate how this theoretical gaze has strongly influenced me in selecting theories and authors. In this chapter the reader will find five paragraphs.

The first subsection (2.1.1) introduces the determinist and apocalyptic hegemonic paradigm operative within the domain of the philosophy of technique, a paradigm that has directed our understanding of how the passage from technique to technology (from ancient to modern society) brought about the end of the role of experience and human action (hence of perception, action, intentionality and praxis). According to this essentialist paradigm, the advent of modern technology has disembedded technique from the socio-

[14] This chapter is based on the content of the article: G. Nicolosi (2013), Essenza, esperienza, prassi, conflitto. Un pragmatismo critico per la filosofia (e sociologia) della tecnica? in G. Mari, F. Minazzi, M. Negro, F. Vinti (eds.), *Epistemologia e soggettività. Oltre il relativismo*, Firenze University Press.

cultural fabric that had safeguarded it for centuries and rendered it an autonomous *corpus* directed only by internally defined parameters of efficiency, functionality and rationality.

The following subsection (2.1.2) outlines the philosophy of praxis, showing that it may be a real antidote to the determinism of the essentialist paradigm. It is suggested, however, that it was precisely the *overshadowing of the concept of praxis*, which Marx's thinking had set center stage in critical analysis on technique, that prompted the affirmation of a logical paradox in the history of Western thought that continues to heavily condition philosophy even today: technique, the essence of man, expands beyond all proportion in modernity, ultimately to negate man in his essence.

The next subsection (2.1.3) explores how *this paradox* has transversally conditioned not only conservative currents of thought but also progressive ones. In particular, I will explain how the essentialist matrix of the philosophy of technique has exercised a considerable influence even on the Frankfurt School, a current that has itself much influenced the social critical thinking of the Left. This influence has ended up by undermining the potentially revolutionary outcome of the philosophy of praxis that the Frankfurt School, at least as a neo-Marxist tendency, should have developed and diffused.

Subsection 2.1.4 discusses how Andrew Feenberg's thinking has brought a philosophical vision to the field of the analysis of technique that is able to *rehabilitate Marx's concept of praxis*. Feenberg introduced a possible way out of the blind alley of having to choose between two unsatisfactory visions: the determinism of the philosophy of essentialist technique versus the insufficient critical potential of constructivism. Carefully combining the anti-essentialism of constructivism with the analyses of socio-political dynamics linked to power relationships and class conflict produced by the Frankfurt School, Feenberg has managed to re-evaluate *the role of experience and praxis in technical action*. This is a revaluation, moreover, oriented to support of the possibility of changing technological development in the direction of *a democratic rationalization of technology* and *a greater participation from below* (i.e., through 'bottom up' approaches).

Lastly, in Subsection 2.2, I will shortly introduce the new theoretical perspective of critical pragmatism aimed at stimulating a new materialist philosophical orientation that emerges

from a fecund (albeit difficult) encounter between the anti-essentialist current of critical theory and pragmatist philosophy. In exploring this critical pragmatism, I will refer particularly to a renewed philosophy of praxis that may creatively recuperate the critical thinking of Marx, Gramsci, Marcuse and Feenberg on one hand and the pragmatist thinking of writers like Peirce, Dewey, Mead, Garfinkel and Sennett, on the other. In particular, I suggest that the traditional conflict between these two schools is rather more ideological than scientific.

2.1 Theoretical background

2.1.1 Technique and technology: the advent of modernity and the end of experience?

Human action, including the technical, increasingly seem to be the terms of an impossible binomial, or perhaps even by now, to refer to a mythical and forgotten past. The increasing pace of relentless techno-scientific development witnessed over the last century or so in particular has, in the opinion of many, substantially uprooted technique from the social and cultural fabric in which it had been embedded for centuries in order to create an autonomous *corpus*, namely, a neutral and independent ensemble, bound to 'inner' logics and dynamics and responding exclusively to linear principles of efficiency, effectiveness, functionality and rationality.

According to a widespread hegemonic interpretation within the field of the philosophy of technique today, this process has been consolidated in relatively recent times with the advent of modernity. The thinking of Umberto Galimberti, in Italy, expresses this philosophical prejudice emblematically. Starting from a deeply rooted proposition in classic philosophical thought that can be traced from Plato through Aquinas and then Kant, Herder and Schopenhauer to Nietzsche, Bergson and Gehlen, Galimberti (2007: 34) asserts that technique (understood both as a universe of resources as well as rationality) should be understood as the *essence of man*, in that it arises as a 'remedy' to the biological incompleteness of the human being, to the deficiency, that is, of his genetic and instinctual endowment. In this vision, the unsuccessful stabilization of the world that characterizes animal experience is overcome by the development of cultural procedures of technical

stabilization based on: anticipation, invention, planning, prediction, freedom of action and of movement.

For Galimberti, precisely because it is the 'essence of man', technique should not be considered a simple 'tool' in the hands of a 'subject' (man). This 'instrumental' condition, claims Galimberti and with him a large part of traditional philosophical thought, characterized pre-modern societies, in which technique was practiced inside the city walls, the residual enclave with respect to nature that continued to govern, with its laws, most of the remaining life of man. But, according to Galimberti's thesis, modernity radically modified the relationship between subject and tool:

> Today it is the city that extends to the edges of the earth, and nature is reduced to its *enclave*, to a fenced-in remnant within the city walls. And so technique, from a *tool* in the hands of man in order to dominate nature, becomes the environment of man, which surrounds and constitutes him following the rules of a rationale that, measuring and gauging itself on criteria of functionality and efficiency, does not hesitate in subordinating the very needs of man to the requirements of the technical apparatus. (Galimberti, 2007: 36, emphasis original)[15]

In the traditional reading of the philosophy of technique it is important to emphasize that this overturning is not the fruit of a socio-historical transformation, but is already in some way inscribed *in re*. We thus find ourselves facing a substantially universalistic and determinist interpretation, one that many authors, as we shall see, recognize explicitly, and others implicitly. Again Galimberti exemplifies this:

> Technique, as a matter of fact, is wholly inscribed in the constellation of *domination*, from which it arose and within which it has been able to develop only through rigorous procedures of *control* that, in order to genuinely be such, cannot avoid being *worldwide*. This rapid sequence was already clearly glimpsed and announced by modern science at its outset when, without delay and with clear foresight, F. Bacon removed any ambiguity and proclaimed: '*scientia est potentia'*. (Galimberti, 2007: 36)

[15] Translations by the author.

Technique in its essence, therefore, would have inscribed a code oriented towards dominion over nature and man. As long as this code remained hidden due to the limited pervasiveness of technique, man would have had the illusion of being able to instrumentally use the technical instrumentation as a means to achieve subjectively set ends. With the passing of time, however, the quantitative increase in the technical arsenal has caused an upset of the means/ends relationship.

The difference between technique and technology, between the one as ancient and the other as modern is founded here on what Hegel in *Logic* defines as 'the transformation of quantity in quality'. When the technical means at man's disposal became sufficient to achieve the ends set by men, the significance of the means was absorbed and hidden by the goal. However since the quantitative increase of technique with modernity renders every end dependent on the necessary means for its attainment, the qualitative condition of the situation is radically transformed. Technique becomes a goal in itself, not because it expresses a precise objective - Severino (1972) would speak here about 'nihilism' - but because the attainment of all objectives always depends on the intermediation of technique[16].

This vision, with its roots in a fundamental philosophical tradition of Western thought, has profoundly permeated the philosophical and sociological production on technique (and techniques). What such an interpretation of technique ultimately challenges is precisely the relationship of man with experience. It is asserted that in the past the reiterated human (and therefore social) experience controlled, defined and characterized technical procedure, while in modernity it is technique that becomes the horizon from which man makes experience in every possible field. In this sense, the human is no longer man, but a functionary; and technique is no longer a tool, but the owner of nature.

In dystopian vein, the clearest example of the abstractness and absolutism of such an interpretation is given by the essentialism of Martin Heidegger, probably the most representative and influential of the philosophers of technique. Here, technology is seen as an impediment to *Being*, in so far as its substantive nature is *essentially* destructive of experience. Again, Heidegger (1927) proposes the classic contrast between technique in

[16] Justifiably, Galimberti sees a fundamental analogy in this process with what Marx had already described in his *Economic and Philosophical Manuscripts* of 1844 with reference to money.

the ancient world (a way of 'revealing' through which the world takes shape) and technique in the modern world. This is the imposition (*Gestell*) of the being (*Dasein*), namely the reduction of being to the shadow of itself. For Heidegger, modern technology destroys sense because of its ontology. If the experienced craftsman was able to connect up matter, form and the ends in order to reveal the truth of the world, then technology *'un-worlds'* its materials and transforms them into functions lacking sense. In this perspective, man becomes an object among objects, a function among functions. Heidegger makes no distinction between technologies, which he sees as all driven by a devastating inner logic. Technology, that is, expresses an independent and arbitrary will destined to subjugate both man and nature.

However impossible it is to render the complexity and depth of Heidegger's thinking in a few lines, it is easy enough to convey the sense that he was not focused on evaluating differences and contexts. Neither does he hypothesize that ends, objectives, uses, interpretations and so on, may in some way have an influence on the ultimate essence of a monster that is both unstoppable and uprooted from the world. And it is precisely because of this central limitation that we take determinism to task today, namely, its excess of abstractness. It decontextualizes, reduces and, consequently, forcibly removes the role that individual and social subjectivity can play in modifying the sense and 'destiny' of processes.

2.1.2 The philosophy of praxis

An antidote to this determinism is offered by the philosophy of praxis. Indeed, the apocalyptic essentialist interpretation, asserting the end of man's experience, decrees the substantial conclusion of humanism, the elimination of significant margins of human acting and, consequently, the technical subordination of all the existential fields of man: reason, truth, politics, ethics, ideology, religion, nature and history itself[17]. We hence find ourselves faced with a vision that goes even further with respect to the very Marxian concept of alienation.

[17] History disappears because the nihilistic nature (its profound lack of purpose) of technique eliminates any sense by which man transforms 'time' into 'history' (through narration).

Indeed, Marx, who had perfectly understood the risks of the transformations introduced by what he defined the new 'civilization of machines', ascribed alienation exclusively to a technical development rooted in capitalist means of production. For this reason, he advocated the advent of a communist society that, overcoming the internal contradictions of capitalism and the iniquitous division of society into classes, would have alienation done away with. For those subscribing to the notion of the end of experience, however, Marx presented a romantic kind of utopian illusion. For them, both capitalism and communism remained 'pre-technological' humanistic categories that presupposed a vision founded on the possibility of controlling the technical instrument by the human subject. The philosophical tradition no longer envisaged such a possibility with the advent of modernity. On this, Galimberti had this to say:

> At this point, also the Marxian concept of 'alienation' appears insufficient, because one can only speak of alienation in a humanistic scenario when there is an anthropology that wishes to be retrieved from its estrangement in production and in a context characterized by the conflict of two wills, of two subjects that still believe themselves to be the owners of their actions, not when there is a single subject, namely the technical apparatus, with respect to which individual subjects are simply its predicates. (Galimberti, 2007: 42)

In effect, Marx (although unfortunately, as we shall see, not all his interpreters, even the most brilliant) was substantially immune from determinist interpretations of this kind, since he based his entire thinking on what in Italy became known as the *philosophy of praxis*. It was the socialist thinker Antonio Labriola (1899) who, introducing Marxism into Italy in the second half of the 19th century, characterized it with this expression, which was oriented toward highlighting the specific interpretation that Labriola gave of Marxism. This was a less rigid interpretation than that put forward by other thinkers (such as Karl Kautsky) and which was to have a great influence on Antonio Gramsci.[18] Thus was

[18] Gramsci saw Marxism not as an ideological and autonomous outlining of history, but rather as a self-sufficient philosophy aimed at understanding the economic structure of society and consequent human relations. It was necessary, he thought, to introduce the social reality of one's own historical period if Marxism were to consider the true complexity of social processes and specific variety of forces at work in history. Marxism had to be understood as a "critical" theory, that is one that did not claim eternal and immutable truths but was ready to interpret the social contradictions according to different historical stages, having at the heart of its analysis labour and the conditions of workers and therefore concrete and material human praxes.

inaugurated a philosophical tradition that was to have an immense impact on political-social thinking and action all over the world.

Basically the term '*praxis*' refers to the process by which a theory or a skill is put into practice, realized or embodied.[19] The expression and concept of 'philosophy of praxis' derive from Labriola's conviction that praxis, understood as individual and social action, is the key essence of all Marxist thought. For Labriola, the idea of 'human praxis' comprises not only work, but also all the activities that become objectified in social relationships, institutions, needs, science, art and suchlike, and runs throughout the entire thinking of Marx and constitutes its fundamental principle.

This conviction stems from the critical analysis that the philosopher of Treviri made, in his *Theses on Feuerbach*, on idealism and so-called 'contemplative' materialism (of Feuerbach, to be precise). In order to better understand the 'practical tension' of Marx's thinking, it should be noted that in the first of the eleven theses written in Brussels, in the spring of 1845, Marx asserted:

> The main defect of all hitherto-existing materialism — that of Feuerbach included — is that the Object [*der Gegenstand*], actuality, sensuousness, are conceived only in the form of the object [*Objekts*], or of contemplation [*Anschauung*], but not as human sensuous activity, practice [*Praxis*], not subjectively. […]».[20]

For the purposes discussed here, of special importance is the affirmation (Eighth Thesis) according to which 'all social life is essentially practical', and, above all, that (Fourth Thesis):

> The materialist doctrine that men are products of circumstances and upbringing, and that, therefore, changed men are products of changed circumstances and changed upbringing, forgets that it is men who change circumstances and that the educator must himself be

[19] In ancient Greek culture, it referred to the activities performed by free men and in Aristotelian philosophy it indicated practical knowledge, whose end purpose was action (as distinct from theoretical knowledge, whose goal was the truth and poietic knowledge whose goal was production).

[20] In the Second Thesis, he clarified this thus : The question whether objective truth can be attributed to human thinking is not a question of theory but is a practical question. Man must prove the truth, *i.e.*, the reality and power, the this-sidedness [*Diesseitigkeit*] of his thinking, in practice. The dispute over the reality or non-reality of thinking which is isolated from practice is a purely scholastic question».

> educated. […] The coincidence of the changing of circumstances and of human activity or self-change [*Selbstveränderung*] can be conceived and rationally understood only as revolutionary practice

For Marx, therefore, just as society produces man, so too is it produced by him. For this reason, his claim that 'philosophers have hitherto only interpreted the world in various ways; the point is to change it' (Eleventh Thesis), is particularly pertinent. In other words, Marx's materialism, unlike other forms of materialism that had been previously produced, established that the validity of philosophy consists in its ability to shape action.

The philosophy of praxis, on which Gramsci would then base the more original part of his work, is therefore not a linguistic expedient, but a conception that postulates an indissoluble unity between theory and practice[21]. The unity of theory and practice would serve Gramsci in order to delineate a series of scientific concepts that enabled him to interpret his contemporary world (hegemony, historical block, common sense, mass conformity in its connection with new forms of individual and collective freedom, passive revolution, etc). Here, I limit myself to noting in general terms that for Gramsci neither the philosophy of praxis itself, nor any science connected to it allows us to make predictions of a determinist nature. There is only one possible way to predict, which is the way that makes it a practical action implying the formation and organization of a collective will[22].

For Gramsci, therefore, precisely because man is a process, he is a series of active relationships, that have a rapport with nature due to the mediation of work and technique, along with the synthesis and outcome of all the existing relationships and the history of these relationships. Nonetheless, change is always possible, because the individual, associating himself with all those seeking the same change (if this change is rational), can also induce a radical transformation of the existing status quo. For this reason, everything is political for Gramsci, philosophy included. The philosophy of praxis must be realized in a dialectic unity of politics and philosophy that is intrinsic to a social group; clearly, the social groups that Gramsci is referring to are the subordinate classes seeking their

[21] Gramsci (1975) would write that such unity cannot be interpreted as a gesture repudiating every kind of philosophy, but rather the affirmation of a unity between theory and practice, and that for the philosophy of praxis, the being cannot be separated from thought, man from nature, activity from matter, the subject from the object; if this separation is made, one falls into the many forms of religion and meaningless abstraction.

[22] This same theory of prediction raises doubts on the determinist conceptions typical of the scientism of the Second International, with it, too, considered a source of passivity.

hegemony. And it is precisely the concept of hegemony, due to the philosophy of praxis and the work of Gramsci, that can become central in an analysis of technique that is neither determinist nor essentialist[23].

In *The Phaedrus*, Plato singled out a region beyond the sky where, in his view, immutable and perfect ideas would reside, attainable only by the intellect and intangible by terrestrial and corruptible beings: the *hyperuranium*. This was by definition a metaphysical, spiritual dimension, beyond space and time. One of the great merits of Karl Marx, therefore, was to lead philosophical thought back into the real world and to abandon the Platonic world of pure ideas, forcing it to deal with the social process of life. Not all his imitators, however, have been able to interpret this mission in an equally complete fashion. Indeed, many have distanced themselves radically, reproducing an abstract thinking detached from the real world of human praxis. This has been particularly true in the specific field of the philosophy (and sociology) of technique.

Here, as indicated (above), the influence of that pessimistic vision of modernity, the idea of technique as the chief culprit of the crisis of culture, society and man heavily conditioned a major part of socio-political thought in the 20th century[24]. This is not to imply that the century just passed only produced techno-pessimism; on the contrary, it was then also that an opposite tendency of techno-optimism also developed, directed towards eulogising technique as the unquestionable source of positive transformation.[25] Thus the '*apocalyptic'* and the '*integrated'* (Eco, 1964) have widely and fiercely challenged each other, and

[23] The concept of "cultural hegemony" was a theoretical contribution of Antonio Gramsci, the chief effects of which have been in the political and scientific field. In the *Prison Notebooks*, Gramsci meant to explain by this concept why the communist revolutions had not materialized in capitalist societies against the predictions and expectations of Marxist theory. For Gramsci, it was because the bourgeoisie was able to impose on other social groups "through daily practices and shared beliefs their own viewpoints, until their internalization, creating the foundations for a complex system of control". Hence, the occurrence of revolutions required above all a cultural change. The subordinate classes needed to be in a position to replace the cultural hegemony of the bourgeoisie with a new anti-capitalist hegemony. The role of intellectuals was fundamental in this. Thus, the classical Marxian model, is overturned. In order to change economic structures, it is necessary to modify cultural and political superstructures. No transformation can be expected deterministically, but rather demands concrete action aimed at changing social and political reality; and, above all, the revolution does not require violent action, because in the long term a power system is not founded on force but on hegemony. In this view, the principle of the philosophy of praxis is materialized: structure and superstructure, theory and praxis are not separate (rather, their separation creates ideology).

[24] Weber's work is perhaps the most indicative of this tendency, but really represents only the tip of the iceberg. Heidegger has already been mentioned, but the work of Jacques Ellul has also acquired considerable prominence.

[25] One may mention, for example, the so-called 'theory of modernization' (Martinelli, 1998), that of 'cultural lag' (Ogburn, 1922), or the so-called 'School of Toronto' (McLuhan, Innis, Ong, etc.).

Marxists also, in spite of Marx's teaching, have been widely represented on both fronts. What needs highlighting here is that the opposing factions have both been locked into the hegemonic paradigm, implicitly and explicitly assuming the determinist interpretation of technique and society. Indeed, just how strong a role determinism and essentialism has played within the context of the philosophy of technique, is revealed by an analysis of the thinking produced by a current that derived its main source of inspiration from Marxism (hence from the philosophy of praxis): the Frankfurt School, known also as Critical Theory.

2.1.3 The crisis of the philosophy of praxis: the essentialism of the "left"

The Frankfurt School was a philosophical and sociological current constituted by a group of scholars originally united (in the 1920s) around the Institute for Social Research at the University of Frankfurt am Main in Germany, under the guidance of the Marxist historian Karl Grünberg.[26] With Adorno, Horkeimer, Benjamin, Marcuse, Habermas and Fromm among its most well-known representatives, essentially this group sought to widen the scope of the Marxist approach of the day with interdisciplinary considerations.

The author who seems to have best critically analyzed the influence that essentialism and determinism have themselves had on the thinking produced by the Frankfurt School is Andrew Feenberg. Located in the main stream of Critical Theory, Feenberg's reflection has nevertheless, had the merit of recognizing the limits and contradictions of the dystopian vision that over time had come to contaminate neo-Marxist thinking.[27] Thus, referring also to Foucault on power, especially in the period of *Discipline and Punish*:

> Marcuse and Foucault stand out in this period as the most powerful critics of the role of scientific ideologies and technological determinism in the formation of modern hegemonies

[26] Many of its exponents were of Jewish origin, for which reason they left the Germany with the advent of Nazism and moved to Geneva, Paris and the United States.

[27] This transformation began to materialize in the 1960s, when the legitimate critique of the movements against 'technocracy' mutated into a repulsion to technique per se, as it became considered the rapacious and insatiable source of environmental threat as well as social injustice. This dystopian perception then bonded with a broader critique of modernity emanating from a humanist culture with elitist leaning, giving rise to a form of left-wing essentialism. After 1968, this was itself challenged from within the new left, re-interpreting socialist ideas with an anti-Soviet perspective, and culminating with advocacy of self-management and direct democracy as the key to interpreting social processes, including those linked to techno-scientific development. A philosophical reflection was here developed (by Winner, Borgmann, Ihde, etc.) which aimed at a democratic framework for the substantivist interpretations (Achterhuis, 2001).

> (Marcuse, 1963; Foucault, 1977). They rejected the idea that there is a single path of progress based on technical rationality, and opened a space for philosophical reflection on social control of technological development. At the same time, they argued, apparently inconsistently, that modern forms of domination are essentially technical. […] (Feenberg, 1999: 6-7)

The contradiction pointed out by Feenberg is evident. The 'dystopians of the left' recognize the ideological (not neutral) nature of technique. [28] At the same time, they oppose essentialism, hoping for and supporting a radical change of modernity, thereby assuming the possibility that technology may be steered towards alternative ends. They thus refute the liberal progressive faith in technique as governed by man but politically neutral (not charged with values and ideologies), but reject also the substantivism that matches an ideological baggage of immutable values to the autonomy of technique. Critical Theory, therefore, shares the idea that technology does not have a determinist nature (since it is controlled by man) with liberal instrumentalism, and shares the principle that it is loaded with values with substantivism. Such a standpoint can only hypothesize change through the substitution of the means-ends (ideology) model that shapes technique.

In fact, however, Feenberg argues, Critical Theorists tended to privilege only one of the two poles between which they built their reasoning, namely : the essentialist (substantivist). This, for instance, is the case of Adorno and Horkheimer who, finding in Heidegger a source of important inspiration, considered instrumentality in itself as a form of domination in which the nature of the objects subjected to control is violated and that of the dominant subject deformed. Albeit representing a valid antidote to the naïve progressive faith of classical liberal thinking, these authors leave no room for reform or 'reconstructive' approaches. But it is also the case that Habermas, whose philosophy of technique can be assimilated to Weber's analysis of bureaucracy, would tend to become frozen 'in the concept of destiny' (2002: 18).

More complex and articulated is the work of Marcuse. While strongly branding the presumed neutrality of technique an ideological construction, he does not seem to deny the possibility of a neutral formulation of technical principles with equal vehemence. He does

[28] Marcuse considers technique ideological in so far as it imposes a domination system and ends on nature and Man that are contrary to their potential for development.

criticize this formulation as abstract, since these principles at the moment they enter into reality must take on a social content bound to the interests of the 'historical subject' applying them. But this interpretation is not understood as undermining technical rationality per se, namely its fundamental imperatives. It seems to aim more at the application of technique than at the nature of technique itself. It appears, that is, that Marcuse fails to go the whole course in his criticism of essentialism (perhaps because he was too closely tied to Heidegger). This would probably explain why his analysis fluctuates between an optimistic vision that foresees the possibility of changing and democratizing technology and an apocalyptic view in which few margins are left for human action to modify an apparently ineluctable destiny.

2.1.4 Feenberg's critical constructivism: the concept of Code and the return of the philosophy of praxis

As recognized, the essentialist hegemony in the philosophy of technique was challenged and questioned by a theoretical and empirical production of the history and sociology of science and technique that was able to show how technical action is characterized by socio-cultural complexity and diversity. For present purposes, this production, whose inner articulation is highly complex, can be defined in general terms as constructivism[29].

Refuting the principles of neutrality and autonomy, constructivism recognizes the fundamental role played by society in determining the very nature of technique. This is not so much one of the efficiency, effectiveness or functionality that explains the success (or failure) of artefacts, but rather the variety of the local and contextual circumstances of a social and cultural kind. Thus, like all social institutions, techno-scientific innovations also prove successful when they enjoy the support of the surrounding social environment (Pinch & Bijker, 1987). For constructivism, artefacts are the fruit of a social and cultural trial-and-error procedure. Their final configuration does not derive from the mere application of technical logic. A great variety of social groups (and alliances between these) participate

[29] Very briefly, the constructivism of the social studies in science and technology (STS) is based on and develops a fundamental postulate elaborated by the so-called 'strong programme' of the sociology of knowledge (Bloor, 1976) at the University of Edinburgh: 'the principle of symmetry'. Following this principle, both the false and true theories of scientific knowledge can be explained by means of social and cultural factors. For a highly valid and detailed analysis of this complex and articulated current, see Bucchi, 2004.

and conflict in this experimental-type procedure. Technological production, which appears linear when analyzed *ex post facto*, is actually exposed to a remarkable open-endedness, ambiguity and, above all, to clear 'interpretative flexibility'. The final artefact becomes a 'black box', an artefact no longer questioned but taken for granted due to the removal of the social matrix that has led to its 'closure' (Pinch & Bijker, 1987). In reality, any single artefact may have not existed or might have been entirely different, according to the social circumstances informing its creation and development.

Starting off from these general assumptions, constructivism has produced a remarkable number of schools of thought over the last thirty-odd years and a vast array of analyses with a marked empirical slant largely oriented towards socio-historical studies of technique. This latter aspect is a considerable merit but also a major limitation of Science, Technology and Society (STS) studies. Indeed, one has the impression of witnessing a specialist and academic breakage of the study object that ends up by putting the more general issues that the philosophy of technique has always raised into the shadow. What is especially missing in STS studies is any theoretical ability to comprehend and render visible the social conflict mediated by science, technology and technical expertise. More generally, behind social constructivism as applied to the study of science and technology, there seems to be a moral agenda that insists on the 'contingency' of the analyzed processes (Hacking, 1999). While this has opened a potential space for the social intervention that substantivist analysis had excluded, from the material historical point of view, it has failed to realise this. In fact, the 'contingency' of this empirical analysis has discouraged the formulation of a positive project of social reform of science and technology.

For many years it appeared that the only dialectic possible was that between the determinism of the philosophy of essentialist technique and the limited critical potential of constructivism, yet this contrast had only created a blind alley from which escape seemed impossible. One of the great merits of Feenberg's thinking has precisely been that of indicating a possible escape route from this asphyxiating *cul-de-sac*.

A student of Marcuse, Feenberg is one of the last direct heirs of the fecund School of Frankfurt: his ideas also comprise the most important and authoritative proposal of a

critical constructivism applied to the social study of technology. By critical constructivism, I mean the attempt to elaborate a kind of third position between essentialism and constructivism. In this way, as we shall see, Feenberg has succeeded in the difficult task of enabling the *philosophy of praxis* to re-emerge from the oblivion to which the same Marxist thinkers seemed to have relegated it.

Inspired by the Marcusian principle of the social nature of rational systems, Feenberg developed the optimistic *côté* of his master, using an interpretation that sets the critical perspective alongside the constructive elaborated in a number of steps of sociological research applied to science and technique. We cannot deny that the balance Feenberg seeks between critical analysis and constructivism is rather precarious, but due to their common roots there are meeting points between the two approaches. Even if often not explicitly recognised by his supporters, constructivism does originate precisely from Marx's critique of ideology, filtered by both Mannheim and Lukács' sociology of understanding. This affinity is visible in the common interest in epistemological questions, in the great attention accorded to 'empirical philosophy', in the criticism of the 'reification' of concepts and in the focus on social practices. However, there are many points of apparently irreconcilable divergence (the concept of totality, the role of dialectics, etc.). Many of these derive from the post-structuralist influence that has shaped constructivist thinking since the beginning, distancing it from orthodox Marxism. To escape these limits, Feenberg has turned to the political implications of constructivism in order to reveal the democratic and liberating potential it offers and that exponents of constructivism had given up on developing. Taking the name 'critical constructivism', his philosophical, sociological and political programme represents one of the most interesting contemporary experiments of the philosophy of praxis. His concept of Code being an emblematic example.

Andrew Feenberg refutes the vision that supports the neutrality and autonomy of technique, and, on the contrary, esteeming Antonio Gramsci's teachings of heterodox Marxism, recognizes all the hegemonic content that is encapsulated within technological objects:

> Technical design responds not only to the social meaning of broader assumptions about social values. The cultural horizon of technology therefore constitutes a second hermeneutic dimension. It is one of the foundations of modern forms of social hegemony.

> As I will use the term, hegemony is domination so deeply rooted in social life that it seems natural to those it dominates. One might also define it as that aspect of the distribution of social power which has the force of culture behind it. (Feenberg, 1999: 86)

Feenberg reminds us that technologies are as they are not because there is any absolute (technical or economic) law imposing them. On the contrary, there are different possible paths and outcomes of development of every technology. Among the several possible configurations, the one that is realized is that which is selected by predominant interests. Once introduced, *ex post*, every technology appears functional precisely because it offers a material support to a certain cultural horizon. For this reason, Feenberg introduces the concept of *technical code* of technology as a code that defines 'the object in strictly technical terms in accordance with the social meaning that it has acquired' (Feenberg, 1999: 105).

Codes prove 'invisible' because self-evident, but they express hegemonic interests and visions in a given socio-historical context. From the Birmingham School of Cultural Studies, and its Gramscian interpretation of the processes of production and usage of mass-media communication, Feenberg learns that order to have a meaning, every hegemonic code must also be decoded and domesticated, over time, by its users. Similarly, referring also to the work of Foucault (1976), Latour (1993 [1991]) and de Certau (1980), Feenberg shows the possibility of resistance tactics (to use de Certau's terms) that are aimed at re-encoding the social order incorporated hegemonically in technological objects.

This aspect of re-encoding is fundamental in unhinging determinist assumptions about technology, such as those characterized by the pessimism of dystopian visions. First, the code is a social product, hegemonic, but which can be re-interpreted and even redesigned and reconstructed. There are no natural and unchangeable conditions supporting its hegemony. This is (merely) the expression of a 'historical bloc'[30] and as such it can be

[30] In *Prison Notebooks*, Gramsci's very important theoretical concept of *historical bloc* refers to a unity between the structure and the superstructure: « 'A historical bloc refers to an historical congruence between material forces, institutions and ideologies, or broadly, an alliance of different class forces politically organized around a set of hegemonic ideas that gave strategic direction and coherence to its constituent elements. Moreover, for a new historical bloc to emerge, its leaders must engage in conscious planned struggle. Any new historical bloc must have not only power within the civil society and economy, it also needs persuasive ideas, arguments and initiatives that build on, catalyze and develop its political networks and organization – not political parties as such' » (Gill, 2002: 58).

overcome by means of an action that is philosophical/practical, aimed at democratizing the same code. Second, the technocratic tendency of modern societies, thematized in the Frankfurt School's concepts of 'total administration' (Adorno), 'one-dimensionality' (Marcuse), and 'technicizing the life-world' (Habermas), is real, but not invincible. One may still conceive of political action starting with the actions of micro-politics, local politics based on local know-how and practices that seek to achieve results in the long-term.

Feenberg's own philosophy of praxis is grounded in an attempt to recreate a real and living relationship between technique and human experience. Much of philosophy presents modernity as the locus where such a relationship seems irremediably lost. Instead, Feenberg's critical constructivism postulates significant margins of manoeuver to recover this relationship. Undoubtedly, the hegemonic scientific and technological development in modernity has artificially separated the world in two mutually irreducible spheres: the sphere of nature in which rationality and the absence of meaning are in force and the sphere of the human in which reigns a wealth of meaning, but equally an absence of rationality. For Feenberg, technology lies right at the intersection of these two spheres, since it is the fruit of the application of principles of scientific rationality, but is also based on the human experience characterizing the interchange with the world (Feenberg, 2010: 181). The auspice of Feenberg is that these two dimensions, rationality and experience, return to communicate with each other.

As outlined (above), all dystopian philosophy has at its base a critique of technology informed by the radical contrast between 'pre-modern craft' and modern technology. The main difference between the two consists primarily in the role that the body plays in the process of constructing artefacts. In the first case, it is chiefly the hands[31] that, through direct or mediated contact of tools with the object, enable the craftsman to take on, in his own *atelier*, a sensitive and sensory relationship with the evolving artefact. Consequently, it is through his own corporeal skills, that the craftsman expresses his own culture and directly encapsulates it in the created artefacts. Modern technology would instead be characterized by limiting (tendentially annulling) the role of the body in technical performance, by producing on a large scale and dramatically impacting on nature and

[31] See Chapter 3.

society. Moreover, the increased pace of innovation renders technology destabilizing for the cultural institutions of social groups. In particular, the application of autonomous and rational scientific principles by technology, causes a social instability, uprooting and breaking local communal ties formed in the production process of the past, along with their ethical and aesthetic values. This transformation may be traced to the process of growing differentiation and specialization of which Max Weber had written concerning Western modernity throughout his entire work. With the advent of modernity, the meaning linked to the social qualities (honour, prestige, gender, symbology, etc.) of the producers (craftsmen) and bound to the practices of production and use of the technical objects would seem to have vanished, sucked out into a kind of black hole.

But is this really the case? Feenberg recognizes that essentialist or substantive dystopian criticism (in particular Heideggerian) is of an ontological rather than sociological form. However, and notwithstanding the fact that the two levels should be tackled separately, Feenberg asserts the need for a sociological 'translation' of Heidegger's ontology, since it appears too radically contrary to common sense and experience (Feenberg, 2010). For this reason, taking up the deeper meaning of the concept of Heidegger's *Dasein*, Feenberg reminds us that our fundamental relationship with reality is based on perception, but counsels that this should not be read as a separate entity from experience, as scientific research (emphasizing cognitive psychology) would tend to have it. The human being does not encounter the world through a chance relationship between the senses and nature, but rather by means of the direct action oriented towards objects endowed with meaning. And *Dasein,* therefore, crucially implies the human being intended as the locus of experience. The subject of action is the being in its entirety, not the mind, a function or a single part of the body.

Heidegger, who we recall was a student of Husserl, emphasized that the Cartesian *cogito ergo sum*, in truth, inverted the logical and ontological relationship between being and thinking.[32] From this perspective, our understanding of the world is that of the way in which we *are*. Moreover, for Heidegger, we encounter the world *practically*. For us, the world is a place in which we act, with our practical tasks, and it is due to this that we

[32] It is necessary to *be* in order to think, and thought (consciousness) derives from being. The nature of being shapes the way in which the world is recognised and understood; studying intentionality as independent from the way in which we inhabit the world is thus erroneous.

attribute meanings to those tasks. For this reason, the idea of intentionality as an abstract entity disconnected from practical interaction with the world lacks value, a kind of modern re-working of the idea of the *homunculus* developed by the current of premorophism.[33] Consequently, for Heidegger, the being is a *being-in the-world* (*Dasein*), embodied, practically oriented, active and intentional.

The philosophical premises of Husserl's phenomenology and the development of this by Heidegger witnessed a fundamental accomplishment in the particular importance assigned to the body and perception in the work of Merlau-Ponty. Here, importance is assigned not only to the body in its 'objective' dimension (shape, legs, etc.), but also to the set of bodily and cultural skills and contextual responses that the embodied agent is able to supply as the outcome of his practical involvement with the world. The philosophical essence of the principle of embodiment is therefore clear: the being is embodied in a phenomenological presence that is the fruit of active involvement in a *lived-in* world.

This move means that the human being is immersed in a world that enables him to act so as to attain certain ends. Taking my argument forward, in order to do act thus, the being uses tools : but tools do not exist as objects *per se*. They are always correlated to a given task and in relation to other tools. For Heidegger, tools can be 'usable' (*zuhanden* or ready-to-hand) or 'simple presence' (*vorhanden* or present-at-hand). In the first case, the technical instrument disappears and becomes a corporeal extension (prosthesis). In the latter, the tool instead becomes a separate object, and we acquire the knowledge of its presence. This distinction is as applicable to a hammer as it is to a mouse or a robot.

For Heidegger (and Marcuse), therefore, it seems evident that scientific knowledge of nature does not have a contemplative origin, but emerges from practical and artisan knowledge.[34] Knowledge and *technē* existed together in the pre-modern world through experience; a house certainly performs the function of a shelter, but it is also the place of privacy and hospitality, family rituals and the expression of the owner's identity.

[33]The 17th (and 18th) century doctrine of 'preformism' alleged that within the seed is the *homunculus,*a miniature but complete adult, ready essentially just to grow. The development of the embryo here was nothing but the manifestation of already formed structures. Leeuwenhoek claimed to have seen the homunculus under the microscope as it awaited growth. Preformism was opposed by epigenism, according to which new structures are formed during the growth of the embryo in a biological development that was gradual (see Chapter 2).

[34] This is strongly echoed in the pragmatist philosophical current.

Technology in modernity, Heidegger claims, would isolate the function and make it an ontological synecdoche (one part is everything). Craft technique reveals the essence of things, while modern technology reveals the functional connection between artefacts in a system of production and consumption.

Feenberg tries to recuperate Heidegger's phenomenological intuition by reaffirming that knowledge is intimately rooted in the enactment of meanings in everyday practical action. This is the fundamental intuition of contemporary social epistemology and the sociology and anthropology of a pragmatist leaning. According to these approaches, meanings is neither an *a priori* nor permanently engraved in the mind like a conceptual map of a fixed world, but is bound to the development of experience (always evolving) rooted in practical action that is purpose-driven and endowed with meaning (see Chapter 4).

While Marcuse expounded this grounding of knowledge in pragmatic action, the pessimism deriving from the thinking of Adorno and Heidegger himself ('Only a God can save us') led him to believe that technological functional rationality had destroyed the twofold dimensionality of the Greek world, so that the supreme world of essence collapse into that of existence, where the absence of every transcendence destroys the generative dialectic between what is and what might be. For example, democracy coincides with the technical institutions that 'fence it in' and it may be that no ideal tension will ever be able to improve it (the one-dimensional society).

Feenberg's idea is that Heidegger's and Marcuse's (dystopian) critique seem to concede an idealized representation of technology : namely, as autonomous, disenchanted, rational, neutral, functional, free from prejudice and mythology, indifferent to nature and human life. In a Marxian vein, however, we know that the human senses guiding experience are not passive (empiricist vision), but actively engaged with the objects of the world. The senses become theoretical by means of practical activity (philosophy of praxis). As Feenberg sees it, therefore, what is missing in Marcuse's critical thinking is a stronger and more relevant grounding in the phenomenological notion of 'lifeworld' (*lebenswelt ; monde de la vie*) and, consequently, in the valorization of the ontological status of experience.

Feenberg understands very well that it is impossible to re-propose the Greek conception of technique with its reference to the essence of things to be revealed. Moreover, culture and tradition no longer hold the binding power they once did. Nevertheless, as the American philosopher maintains, it is appropriate to analyze the modern relationship with technology by defending the importance of human experience and completely abandoning reductionist naturalism. Our encounter with the world is always of a practical kind, and in our daily experience we work with materials that are endowed with meaning. Experience is thus always endowed with this 'two dimensional' ontology (Marcuse), since the senses are 'directly theoreticians in their practice' (Marx).

For Feenberg, therefore, technology has a two-fold existence. On one hand, it exists as a rational and scientific mechanism in the world of functional causality; on the other, it exists as an object endowed with meaning, in so far as it is an object of the world of experience. This duality does not consist in the juxtaposition of two different viewpoints (one subjective and the other objective), however; rather, it is an inextricable interweaving that anchors the most intimate essence of technology, because *the action endowed with meaning is the precondition of scientific knowledge itself*.

The twofold dimensionality of technology represents an optimistic opening with respect to the potential to effect change in the world, and thus comprises a theoretical passage of enormous political implications. Technology, says Feenberg, is not only not immutable or unchangeable, but can be democratized and rendered more human(e) (he speaks of a 'democratic rationality'). This offers a space, however difficult and complex the effort needed to fill it, for an intervention that recuperates human action and restrains the superpower of technocracy.

2.2 A different perspective on *praxis*: an overview of 'critical-pragmatism'

Of course, critical theory has not been the only philosophical movement to counteract essentialism '*in the name of praxis*'. Philosophical pragmatism had a different, but equally effective role. A philosophical movement that developed in the United States towards the end of the 19th century and later spread to Europe, pragmatism remains one of the most

innovative contributions of the United States in the philosophical field.[35] The chief merit of pragmatism consists in having recovered and valorized the concept of *praxis*, too soon forgotten by philosophers and sociologists who have analyzed technical phenomena. As already suggested, this concept may be employed to demonstrate the role and importance that human experience has played and still plays, in the sense of practical ability, creativity and sociality, in technical and technological action (above, 2.1.2). Nonetheless, it is right to point out that pragmatism has also had the demerit of not always giving due importance to the turbulent political and social processes that technological development entails and that are grounded in the dynamics of power and class differences - which critical theory, on the other hand, has been able to do very well (2.1.3).

Nonetheless, the philosophical landscape, over the last century, has also been characterized by several critical versions of pragmatism. These versions rediscover the radical political spirit of classical pragmatism, and make an effort to elaborate an updated progressive version able to criticize the shortcomings of liberal democracy and the globalized capitalism. Critical pragmatism has the potential to integrate just what pragmatism and critical theory has best been able to produce in the philosophical reflection applied to technology.

Unfortunately, this minoritarian philosophical movement is often considered as heretical, as many obstinately consider pragmatism as antithetical to Marxism. In my view, the differences - which undoubtedly do exist - have been overemphasized for ideological more than scientific reasons. It is true that American pragmatism, especially that linked to the work of John Dewey, has been dismissed by Marxist thinkers as the intellectual instrument of liberalism and utilitarianism or more generally, an epistemological model that functions in defence of the status quo. On the other hand, many scholars of pragmatist vocation have regarded Marxism as a philosophical system that has supported and justified the totalitarian

[35]It is hard to characterize pragmatism with a simple definition, since the movement is not in itself coherent and has multiple alternative directions. Simplifying crudely, with Charles Sanders Peirce pragmatism theory appears as the *theory of meaning* identifying the meaning of an expression with the whole of the practical consequences that derive from its acknowledgment; or, with William James and John Dewey, it is a *theory of truth* tending to identify truth with practical usefulness. In sociology, following the work of Schütz, Mead, Goffman and Garfinkel, the approaches of symbolic interactionism and ethnomethodology can be considered as a pragmatist derivation.

power and status quo of the Soviet Union. It is my deep conviction that both affirmations are substantially lacking insofar as they are reductive and ideologically conditioned.[36]

From a philosophical viewpoint, there is an affinity between pragmatism and the philosophy of praxis that goes beyond the terminological. We may recall, for instance, that pragmatism (just like Marx's philosophy of praxis) conceives of thinking not as the passive contemplation of a pre-established reality or mere reception of external sensory data, but as a *process of active intervention on reality*. Marxism and pragmatism both affirm the principle that in the relationship between knowledge and action there has always been a bias in favor of knowledge in traditional philosophy. Thus, in late 19th century America, the mediaeval ideal of the 'theoretical' life, namely, a life given over to meditation and the search for a-historical truths, was replaced with the ideal of the truth as doing, as action, as activity.[37] One therefore witnesses with pragmatism, as with Marx, a reassessment of action in philosophy as in life. The traditional conception of truth as the conformity between thing and idea - *adaequatio rei et intellectus* - like a compliance between being and thinking, is refuted. On the grounds of reassessing action, truth is transformed from a mental state to corporeal and contextual activity, the concrete and embodied cognitive doing. Lastly, like Marxism, American pragmatism is also a philosophical doctrine oriented towards the future, from the moment that it considers the truth of an action as future effect of the same action.

Marxism and pragmatism both refute the philosophical appeal to the impartial search for certainty and, consequently, they challenge Cartesianism and its tendency to divide experience into two clearly separate and opposing dimensions, the subjective and the

[36] In effect, the main political differences between the two schools are attributable to the fact that pragmatism has had a radical progressive but reformist democratic orientation in the United States, whereas elsewhere Marxism has more widely influenced revolutionary movements. But it is also interesting to remember that, politically speaking, Dewey was oriented towards the movement of American labor and, albeit never formally joining socialist parties, exuded socialism. The American socialist reformer William English Walling - founder of the National Association for the Advancement of Colored People (NAACP), the Women' s Trade Union League (WTUL), and the American Federation of Labor (AFL) maintained that 'pragmatism is socialism'. Nonetheless, Dewey's socialism was not a state socialism, but decentred, egalitarian, democratic and without classes, a socialism neither collectivist nor monopolist, but in which the value of individual freedom (and of the property of small producers) was decisive (Westbrook, 1991).

[37] It is worth recalling that Marx, influenced in this by Fichte, asserted in his anthropology that human beings must be fundamentally understood as active beings, that is with respect to their activity. This should not be confused with 'work' (wage-earning) or *Arbeit*. Work is the human activity in the phase of capitalism and antithetical with regard to free human activity. In the *Paris Manuscripts*, Marx was already asking: 'For what is life if but activity?'

objective. Both avoid falling into the trap of absolute subjectivism, recognizing in rational analysis a role that is necessary but insufficient to understand and experience an indefinite and constantly changing world.

Rytina and Loomis (1970) have gone further in the analysis of the affinities. They have asserted that Marxist materialist epistemology (founded on dialectics), in refuting the metaphysical interpretation of the world, and pragmatic epistemology, as based on a valorization of the 'experimental situation' over external, formal systems of validation (like logic or mathematics), have a common vision founded on the unity between theory and practice and the principle that it is what man does that determines what may be considered 'real'. For this reason, dialectical materialism and pragmatism imply an activistic criterion of truth hinging on a logical system depending on social action.

Dewey's thinking, with its (Darwinist) emphasis on the ability of men to adapt to the contextual conditions of the external world with their own intelligence, undoubtedly may have led some of his interpreters to minimize the question of the divisions of power in society and allot related issues to the space between man and nature (rather than between man and man, as does Marxism, insisting on the class struggle). To resolve social problems, Dewey counts entirely on the role that educational processes perform. If the world is unjust, it can be changed. All that is needed, he thinks perhaps naively, is a greater 'diffusion' of intelligence. For this reason, his perspective is not revolutionary, but reformist and progressive, coherently with an epistemology that considers reality a processual phenomenon.

A number of authors, for example White (1995: 314), claim that pragmatism, albeit in a position to usefully revitalize critical theory, cannot inherently be considered an authentic current of social criticism. This is because pragmatism, being a social philosophy based on contingency and multiplicity, represents an ethos that expresses a sensibility rather more than a tradition built solidly on a normative order. Such a sensibility is substantially 'problem-driven' and therefore, White continues, incapable of being 'suspicious' with regard to power structures. And yet, thanks also to the interest shown by authors with a critical background, such as Jürgen Habermas, this dilemma (can pragmatism be a fecund critical theory?) can and must, in my view, now be subject to review.

Kadlec (2006) is one writer who, clearing the field of the unjustified accusations of positivism that various authors of the Frankfurt School (Horkheimer in particular) have levelled at Dewey, clearly shows how it is possible to speak of the existence of a critical pragmatism, or at the very least, reduce the gap between the two traditions of research. According to Kadlec, the mutual incomprehension between the Frankfurt School and pragmatism may be ascribed to the interpretation that Antonio Gramsci made of the latter, declaring that pragmatists were incapable of seeing hegemonic structures at work in the creation of 'common sense',[38] thereby undermining their critical reflectivity from the outset.[39]

Gramsci, impetuously, believed that pragmatist intellectuals would certainly be able to improve the conditions of workers, through the constitution of unions – which, effectively, they did. Unions could only marginally improve conditions in the factory, however, while the movement of the Factory Councils (*Consigli di Fabbrica*) that he motivated was intended operate on a more profound scale, to recreate the factory as the nucleus for the future proletarian state. For Gramsci, pragmatists constitute unions, while the purpose of the philosophy of praxis was to foment the revolution.

It is clear that Gramsci's critique is based on a different conception of history. This diversity is also founded on the genuinely anti-foundationalist nature characterizing pragmatist philosophy and that rendered the universal laws of history that Marxist historicism promoted incomprehensible[40]. As Kadlec sees it, however, the deficiency of critical reflectivity denounced by Gramsci is unfounded. In particular, the two key categories of Dewey's thinking, 'reconstruction' and 'individual', refute this.

Regarding reconstruction, Dewey claims that science can contribute to a rebuilding of the lost relationship between reason and experience, freeing human beings from a static vision of the world and enabling a possible transformation of the status quo. In effect, this would

[38] A concept that is very close to the notion of 'habit' elaborated by James.

[39] According to the Sardinian philosopher, pragmatism reeked of utilitarianism and though he thought the centrality that pragmatists gave to the political dimension of daily experience to be right, he considered this focus insufficiently backed by critical reflection. For Gramsci, the great virtue of pragmatism resided precisely in its understanding of human acting as something social, founded on interaction. But the relationship between experience and organism postulated by pragmatic doctrine was, in his view, overly limited in its conception.

[40] Perhaps the more general problem needing discussion is whether it is possible that an anti-foundationalist theory can also be radically critical ; my answer would clearly be yes.

comprise the end of the founding dualism of the Greek thought – particularly the distinction between experience and reason postulated by Aristotle - which has severely and negatively conditioned the whole tradition of the Western thought and should be revealed and dismantled.

Dewey (1920) explains the origin of this dualism in the need that Greek philosophers had to justify a conceptual system that might preserve traditional beliefs, in an (ultimately rather extreme) attempt to conserve the traditional forms of authority (theirs). In the establishment of a final and normative distinction between reason and experience, the former (Truth) was transformed into a locus of the highest and most definitive reality that subjugated and disciplined the latter. This classification came to condition all Western thought by enabling transcendental reflection to reveal reality solely through Reason (thought, philosophy). It was a false dualism, Dewey argued, handed down to us in the form of the decidedly anti-democrat propensity of failing to credit to experience as a complete critical faculty, that, in turn, justified the monopolization of power in the hands of a select few. Indeed, according to Dewey, the reason/experience duality has echoed through the various (leisure/labor, thinking/doing, etc.) dichotomies at the root of the failure of democracy in Western societies underwriting a power structure that monopolizes the benefits of intelligence and best methods for the profit of the privileged few.

The question Dewey takes his analysis to raise is that of how it might be possible to realize the critical potential of daily experience and transform it into an active reservoir for social change. His answer lies in the role that science (and technology) can play.[41] For Dewey, we are indebted to the scientific revolution, since its development has revealed that reason does not occupy a separate kingdom from experience and that intelligence is not something possessed (or not) once and for all.[42] Here, the contrast between Dewey and Horkheimer is played out, in that for the German this view leads to support of the status quo, whereas for the American, it represents a revolutionary vision with respect to elitist conceptions that ultimately legitimize oligarchies.

[41] For such faith in science, the Frankfurt School has accused him of naïve optimism.
[42] Both reason and intelligence are aspects of a *process* in which experience plays a founding role.

This emphasis on experience given by pragmatist philosophy does not mean that its advocates (prominently Peirce and Mead, as well as Dewey) intended to diminish philosophy. On the contrary, they supported it, but a philosophy that worked in the direction of realizing the possibilities of experience as the dynamic social medium of critical reflection (Kadlec, 2006: 535). One might say, contrary to Horkheimer, that Dewey's position is much nearer Gramsci's philosophy of praxis than Bentham's utilitarianism. It was not by chance that the then young American Marxist philosopher Sidney Hook should have been converted to pragmatism on encountering Dewey's work, defined as a brilliant application of the principles of historical materialism (Hook, 1987).

Moreover, for Dewey, this social and liberating dimension of free cognitive enterprise must always be valued for its deeper societal implications. If these are forgotten, then indeed, there is a risk of falling into the utilitarianism that serves the interests of one class (social category) at the expense of others. It is this social purpose of philosophy that gives pragmatism its normative significance and moral force. The social and institutional order should not be considered a means to obtain 'things' to the advantage of individuals. Rather, it should be an instrument for the 'creation' of individuals.[43]

Authoritative confirmation of the existence of an affinity between critical theory and pragmatism is also given by Karl-Otto Apel, much of whose thinking developed through an on-going debate with authors such as Wittgenstein and Peirce. In a significant overview, Apel (1981: 1) asserts that in the world of industrial societies there are only three philosophies that 'work', in the sense that they manage to mediate between the theory and practice of life : Marxism, existentialism and pragmatism - three currents of thinking, that is, which offer a mediation between theory and praxis, representing the most important outcome of the philosophical response to the 'disintegration' (of this mediation) caused by Hegelian idealism (commonly known as absolute idealism). Moreover, Peirce's pragmatism, with his theory of signs (semiotics) and of rationality[44] represents for Apel

[43]In Dewey's pragmatism (1930), individuality in itself and for itself would have no value. It should instead be considered closely interwoven with social life, since it is bound to the broadening of the individual's ability to develop free research, social intelligence and critical reflection in conditions of equal opportunity within the community.

[44]What Apel calls 'meaning critical realism' (see also Footnote 4).

one of the benchmarks of a critical theory of society[45] (Strydom, 2011). This connection, one might add, has led some authors (e.g., Smith, 2009) to speak of the effective or potential existence of a 'critical pragmatism' and of a so-called third generation of the Frankfurt School. Larry A. Hickman (2001), for example, has explicitly asserted that some of the pieces of the Feenbergian philosophical puzzle seem in his view to clearly hinge on the current of pragmatism (Feenberg explicitly cites Dewey in *Questioning Technology*). [46]

The link between critical theory and pragmatism also emerges from other sources, including the explicit acknowledgement that Habermas, among the few European philosophers to do so, has publicly paid towards pragmatism and also from the important work of reconstructing the influences of American pragmatism on European thinking made by Hans Joas (2005).[47] In an interesting article that recalls Habermas' tribute, Shalin (1992) has sought to show that integrating the pragmatist perspective on experience and open-endedness can favor a corrective remedy to the emancipatory agenda supported by critical theorists. In particular, Shalin's article highlights the gainful comparison between the disembodied Reason of Habermas and the embodied reasonableness of pragmatist thought. A very strong link between pragmatist thinking and critical analysis of society, in a sociological frame, may also be understood as emerging from the sociological work and the social commitment of Pierre Bourdieu (Shusteman, 1999).

2.3 Conclusion

Critical theory and pragmatism are not, as often claimed, incompatible. On the contrary, the encounter of these two traditions is here argued as extremely rewarding, not least because pragmatism may represent a valid antidote to the venom represented by the essentialist and determinist temptation and which is always potentially present within critical thinking. Likewise, critical thinking can provide pragmatism with the tools and an attitude to a social analysis that may enable its interpretation of the conflict and distribution

[45] Apel recognizes and includes Peirce among the left-Hegelians (like Marx), that is, the classical foundations of Critical Theory.
[46] It should be remembered that Feenberg (2003), albeit acknowledging the importance of Dewey's thought, has clearly rejected this interpretation.
[47] In Italy recently, Marsonet has retraced a line of affinity also between Dewey's and Gramsci's thinking (Marsonet, 2012).

of interests between groups and classes in a more systematic and dialectical fashion. In other words, the fundamentally *organic* attitude of pragmatism that tends to produce an excessive faith in the fact that all conflicts can, in some way, be reconciled in a social whole, may be favorably counterbalanced with a focus on the dynamics of dominion that power, prestige and wealth enact in a conflicting manner within a social context.

However, critical pragmatism has the potential to integrate just what pragmatism and critical theory has best been able to produce in the philosophical reflection applied to technology. I suggest that this perspective might support a philosophical re-foundation of a new *philosophy of praxis* in order to instigate a constructive lecture of technology. With the work of some authors, such as Hans Joas, this perspective does seem to be gaining ground. At least, the philosophical nuance shown by critical pragmatism may help the philosophy and sociology of technology in supporting a theoretical anti-deterministic approach to technology based on the concept of praxis. This could be, I would say, the basis of a new materialism with a deeply pragmatist philosophical influence. It is precisely this theoretical gaze and sensibility that has guided investigation of the research questions presented. Actually, the conviction prompting my development of this thesis draws on the work of authors influenced by pragmatism, within the field of research termed 'Critical Construction Technology' (CTC). This stems from an awareness that it is possible and indeed useful to find convergences between these two apparently opposite currents in order to grasp the opportunities of a controlled and positive development of technology.

I have used this gaze in formulating the research questions and also in selecting theories and authors to give an answer to these questions. It is important to emphasize (again) that this work is not on critical pragmatism per se. Rather, the cultural matrix, sensibility and ambition of this perspective has guided the direction of the research. Equally, as I will discuss in Chapters 5 and 6, the idea to develop a critical reconstruction of technology grounded in shared and participatory social practices (what I named *re-skilling practices, tailor-made practices*, etc.), as well as the choice to anchor these practices within the *open source* logic and action model are deeply informed by this critical pragmatic nuance, as elaborated in the following chapters.

Chapter 3

The bio-anthropological roots of experience: an epigenetic insight[48]

3.1 Introduction

In human life 'skills' are an ineliminable anthropological condition since they are bound to the very biological status of man. With skills, through learned, intentional, and plastic body-rooted experience man enters creatively into relation with the surrounding environment. Man thereby changes and is changed by the environment in a mutual exchange where it is not possible (if not in an abstract analytical way) separate the man from the world. The problem is that hegemonic scientific culture and public opinion are not aligned with this.

Mainstream science and popular culture are grounded today in a genocentric cultural paradigm itself defined by a determinist 'informational' mythology where 'skills' and 'experience' have a very marginal position as compared to the role played by formally defined inscribed instructions, both physical (genes) and mental (for example, Richard Dawkins' memes). What is new today is that a *corpus* of advanced analyses has revealed some flaws in this mythology.

The main aim of this chapter is to discuss the following (extended) research question: What is the bio-anthropological explanation and justification of the importance of experience in human culture? And is there an epistemological paradigm able to represent such a foundation in the life sciences today? The response presented here is to suggest that the idea that epigenetics has of the organism scientifically supports a socio-anthropological

[48] This chapter is based on the content of the article: G. Nicolosi & G. Ruivenkamp (2012), The epigenetic turn. Some notes about the epistemological change of perspective in biosciences, *Medicine, health care and philosophy,* (15), 309-319.

idea of man as a real *being-in-the-world*, namely an intentional body that lives out a relationship of reciprocity with the surrounding environment (physical and social).

An intensive debate in both science and the wider society on the development and impact of genetics and genomics has been taking place over the last three decades. This debate has important scientific, philosophical, economic and symbolic implications. The general assumption of this chapter is that in spite of the wide range of actors and institutions (scientists, politicians, churches, etc.) animating this discussion with a variety of different and often opposing voices, the debate in itself is situated within a hegemonic scientific and cultural paradigm which is built upon specific conceptual interpretations of life that demand the development of a critical reflection. This chapter reflects on the basic epistemological pillars of that hegemonic paradigm, particularly in the light of the emergence of a new scientific and epistemological development – an 'epigenetic turn' - which leaves the former in serious crisis.

The hegemonic paradigm assumed by both the opposed sides in this debate is built upon the assumption that life is fundamentally *detached* from the environment in which it develops. The assumption of detachment is anchored in a long Western philosophical tradition of dualism probably linked in turn to a platonic tradition based on the contraposition between body and soul and then, facilitated by Christianity, reproduced in every cultural domain (Galimberti, 1983; 1999). Modern genomics represents an example of this paradigm in that it conceives life as composed of two parts, the germplasm and somatoplasm, with the germplasm (actually defined as DNA) containing all the necessary information to shape (activate) the organism (somatoplasm) which, conversely, receives and reacts (passively) to the instructions inscribed in the germplasm.

The active/passive dichotomy assumed in genomics of germplasm and somatoplasm (or genotype and phenotype), has hereditary information moving only from genes to body cells and never in the opposite direction. Germplasm and somatoplasm are bound to each other through this unidirectional, causal relationship (the so-called 'Weismann barrier'). In this vision, great weight is given to the genetic *design* of life, the genetic programme that is incorporated into our cells as the result of the natural selection of random genetic mutations. Evidently this concept of life reduces biological organisms into compliant

entities that are i) governed by internal mechanisms (the actual locus of 'life'), and ii) detached from the world around them (the given within which they operate).

The epistemological frame of reference of an assumed detachment of life is, however, increasingly challenged. Through epigenetics, renewed interest has developed in the relevance of relationships between organisms and the external environment. In a line of investigation further outlined below, laboratory research has shown that environmental stimuli can be genetically assimilated and transmitted to subsequent generations, and even when the stimulus that generated them is no longer active (Waddington, 1953; 1959). This chapter thus refers to various bio-scientific studies that challenge the currently dominant gene-centric paradigm.

The following first section presents some of the core scientific assumptions upon which the hegemony of a unidirectional and informational basis of life rests. It shows that the standard, dominant reading of DNA derives from a long historical and epistemological tradition. The second section presents bio-scientific arguments around which an alternative paradigm is constructed, considering the genome as an *embedded* and *plastic* entity. This section discusses various new routes that are being followed in reading the role of the genome in life processes, routes recognizing the creative role of the organism-within-an-environment, and which thus have the effect of exploding the traditional nature/nurture dichotomy. Establishing the point of departure for the next chapter, the concluding section argues that such a new (or renewed) conception of life has important implications that can also inform the social sciences in a reorientation of their epistemological basis and lead them to a different approach to technology development.

It will appear clear, indeed, that the picture of man to be sketched here is based on a being bio-ontologically grounded in experience. Indeed, the epigenetic interpretation of man dismantles the informational model and suggests that, analogously and *a fortiori*, in the cultural dimension also, the human being must be considered not as an organism controlled by an informative coding lodged in his mind, but importantly as interacting with its environment. Looking forward, this line of reasoning will thus employ the epigenetic paradigm so as to challenge informational determinism on the social as well as the biological level. Indeed, it will be argued, the epigenetic analysis does offer 'hard'

scientifically support for a socio-anthropological idea of man as a real being-in-the-world - a being, that is, which facing processes of growth, development and decay, incorporates in his very anatomy (muscles, neurology, etc.) particular skills and habits that render him plastically intertwined with the surrounding physical and social conditions.

3.2 The gene-centric approach: the hegemonic paradigm

Watson and Crick's 1953 discovery of the structure of DNA led to the formulation of the protein synthesis – the equation of one gene, one protein. This was interpreted as the uncontroversial confirmation of the Modern Synthesis, or neo-Darwinism, presenting a picture of the human genome as an ordered and sequential ensemble of basic mechanisms, the genes, seen as informational bricks governing the 'functioning' of our body just as programming languages direct the operation of computers. David Le Breton has dubbed this interpretation 'genetic fundamentalism', or the informational myth (Le Breton, 2004). The reading and interpreting of biological processes are strongly influenced by this myth and the tacit rules of scientific communities as elaborated within the hegemonic social-historical context (Kuhn, 1962). Essentially, the modern development of science (biology) development has led to a disconnection of the DNA from the developmental processes of organism and to the perception of DNA as merely an informational mode, independent of its environment.

3.2.1 DNA as a code: the informational metaphor

Lily E. Kay (2000) has described the socio-historical process through which the DNA-based protein synthesis was transformed into a very powerful informational metaphor, as the *code* (or the book of life). Metaphors are very powerful tools in determining '*knowledge dynamics*' (Maasen and Weingart, 2000) and like other successful representations used and assumed within scientific and wider public discourses ('the big bang', 'black holes', etc.), this informational metaphor has played a vital role in the imaginings of and about genomics. Coined in the field in 1950s, the code metaphor has heavily influenced the subsequent development of molecular biology, even though many scientists at the time of its development protested against this biasing analogy. Kay

showed that the idea of encoded information was strongly shaped by the development of communication techno-sciences at that time, which facilitated the embedding of 'information thinking' in many scientific disciplines. This included the life sciences, where it determined a paradigm shift from proteins to DNA. Today, as Kay notes, it is difficult to think about protein synthesis without referring directly and immediately to information codes and writing technologies - previously, up until the 1940s biology had been characterized by the predominance of a very different metaphor, that of *specificity*[49](Kay 2000).

The social affirmation of the informational representation of life as a code caused something of a 'fetishizing' of DNA, transforming *every* living form into an 'organized sum of information' (Le Breton, 2004: 1). In fact, one of the main benefits of the information category has been precisely that of its neutral and universal characterization. Information has been widely used by scientists applied through and thereby defining a variety of conceptual domains without any reference to a specific 'who', 'where', 'when', etc. It is a sort of wonderful, universal Esperanto that can be used at any given moment to translate any living form into a series of instructions. This transformation, according to Le Breton, has gradually removed living material from the scientific horizon, because 'information effectively puts all levels of existence on the same plane and empties things of their substance, their value and their meaning in order to make them comparable' (*ibid*). Life *is* information in its genetically encoded form. The analysis suggested here is that the success of the code metaphor within scientific thought lies in its capacity to meet a classical Western epistemological dualistic juxtaposition: form versus substance.

3.2.2 The body as a machine: philosophical background of the form/substance dualism

We can trace the foundational form/substance dualism back to Plato and Aristotle's ancient speculations, but we find in Descartes its full modern expression. As Carlo Sini (1993: v-xx) remarks, there are works marking the passage to a new era and Descartes' *Discourse on the Method* is probably one of the highest and certainly one of the most emblematic example of these. Although Descartes developed ideas that we cannot consider original for

[49]In this respect, Kay shows that the role *specificity* played within biology the role, material cause played in Aristotelian thought (as the opposite of *form*). In terms of Platonic dualism, again, specificity is anchored to the body and its (specific) ever changing relationship with the environment - whereas, information is anchored to the idea of soul and its abstract, immutable and incorruptible condition (Galimberti, 1983).

the time – Copernicus, Bruno, Kepler and Galileo were probably, in fact, the outstanding protagonists of the modern, or 'Western', epistemological revolution – Descartes' work is widely considered the foundation of modern thought because it was an organic systematization of a radically new cultural climate. It was a manifesto leading to a new *mechanistic philosophy.*

The new 'Cartesianism' gave expression to the rise of a new *scientia activa*, oriented to man's *intervention in nature,* coupling knowledge to action, wisdom to power. This new science contrasted the old *scolastica scientia contemplativa,* which was merely oriented to contemplate the grandeur of Nature created by God. The 'machine' became the paradigmatic figure of this new philosophy applied to nature (the external world), as well as to human body architecture (the internal world) through medicine. With the fallibility of perception leaving only the mental state of consciousness or awareness (the *cogito*) as unquestionably valid, which Descartes crucially blurred into thought, and thence to reason, so mathematics and geometry became considered the main sciences with which to understand the machine. Rigorous measurement combined with logical and formal abstraction, where the qualities required for and of this knowledge, enabling man to 'steal' the law governing the perfect mechanisms of the natural machine. Thus did Koyré (1948) characterize the new philosophy as the transition from the vague to the precise ('*du monde de l'à-peu-près à l'univers de la précision*'). And thus did 'the clock' become the metaphor best suited to symbolize the precise (rational) structure of the machine, prototypically representative of the 'logic of interdependence', accuracy and efficient predictability (Mumford 1934). And, indeed,Descartes depicted the Universe and Nature as well as the Human Body like they were perfect machines.

At the same time, Descartes introduced within the epistemological paradigm of modernity a new element: the mind/body dualism.[50] And, separating the body (*res extensa*) from the mind (*res cogitans*), he recognised the superiority of the latter, because only the latter was capable of thinking (*res extensa* being but a 'mirror reflection' – Galimberti, 1983). It was the *ego cogito* that lived the world, not the human 'I' as a whole. For Descartes, in fact, 'mind would not cease to be what it is, even if the body was not' (Galimberti, 1983). So,

[50] Although, again, Descartes did not actually introduce this dualism, as it was already implicit within the ancient Platonic-Christian tradition. Rather, he explicitly separated the body from the soul (or mind) in a secular and scientific framework, extending the power of a rational systematization to this decoupling.

Cartesian thought introduced the possibility of a disjunction between body and mind, and reduced the human being to the essentialism of pure spirit (or, disembodied consciousness) and this, in a nutshell, is the cultural background which made possible the hegemonic imaginary in modern society of the anatomic body.[51]

The *disjunction of body and mind* enabled a focus on the body (and the material world), perceived as disconnected from the mind, thus facilitating the development of modern science (as an 'objective' methodology). In fact, the traditional separation of matter from spirit became a separation of the body from the person (Le Breton, 1990). From then on, the person was associated with the verb 'to be' (I am, a form of solipsistic consciousness). The body, on the contrary, was associated with the verb 'to have' (classically, bundles of properties). So, ontologically, 'I am', but 'I have a body'. Society had never been so far from the holistic dimension of the communitarian characterization of the pre-modern era. The body had become a residual entity, emptied of and detached from its spiritual environment. It became a corpse to dissect, a machine to operate (on), the human body as holistic entity in the pre-modern era now reduced and objectified by scientific investigation and experiment (Le Breton, 1990: 61). Descartes gave philosophical legitimacy to a new meta-structure aspiring to geometric precision. He did not create this new sensitivity, but he was successful in revealing it and this machine (body, nature) henceforth appear as formally organized, to be studied with formal tools like mathematics eponymously heralded just a half century after the *Discourse* by Newton's *Principia*.

3.2.3 The hegemony of the informational model of life

Susan Oyama (1998) suggests that the ancient mind/body dualism is reproduced within the genocentric paradigm in biology. This paradigm opposes genotype to phenotype, ascribing to the former a deterministic influence on the latter. Here, again, the form (genotype) defines the substance (phenotype), the physical, embodied organism, only a material and

[51]In fact, Descartes gave cultural legitimacy to a pre-existing medical practice and an anatomical knowledge that had been emerging in Italy (Padua, Venice, Florence) since the fifteenth century, and had reached a turning point a century before, in 1543, with the astonishing *De corporis humani fabrica* by Vesalio (the Flemish Andreas van Wesel). In Padua, at that time the most important Gymnasium in Europe, Vesalio confuted the Galen's anatomy, discovering a 'new body'. In this sense, Vesalio was the main author of a revolution less well known but no less important than that of Copernicus (with his *De revolutionibus orbium coelestium*,1543). We may say that 'the macrocosmic revolution of the 'universe factory' coincided with the microcosmic revolution of the 'human body factory'' (Cosmacini, 2003: 234, trans. the author).

contingent expression. In this view, it is only the form that is really important, for which we employ abstract tools (algorithms, information science, etc.) in order to capture the essential information and which cannot be tricked by changing appearances. The onto-genetic development (the substance) is controlled by the genetic programme (form). In this sense, a sort of preformistic model emerges, according to which a fertilized egg contains the organism design and all the information required to specify its development (Lewontin, 2002: 6). Metaphors such as 'the genes as programmes' and 'DNA as information', very common amongst biologists, represent a contemporary version of this modernistic retreat to the so-called 'homunculus'. That is, the paradigm which orders the conceptualization of the genome as a 'barrel' containing discrete information units, linearly linked to a unique determination chain from genotype to phenotype, belongs to a hypothetical construction of reality which is increasingly in tension with actual observation in the laboratory.

Lewontin (2002) argues that the particular attention paid to similarities and invariance between organisms and species has led developmental biology to emphasize the deterministic power of DNA. Ultimately, from this perspective, organism development is no more than the mere 'unrolling' of a pre-determined genetic programme –to the hard determinist extent wherein knowledge of the complete DNA sequence of a certain body entails the ability to develop that body. Lewontin also argues that the usage in science of concepts like 'self-replicating DNA' and phrases like 'DNA fabricates proteins' are likely to further the misleading instructionist paradigm. Very little or no weight is given to the internal or (worse) external environment; evolution is envisaged as a process producing (novel) genetic programmes (a sort of *design*, or informational software) that control ontogenetic development. A linear influence is assumed, and, rather than mutual interchange, an unbridgeable divide of ontogeny from phylogeny.

Le Breton expresses this conception that every living being is an organized sum of genetic information in terms of a hegemonic paradigm of 'genetic fundamentalism'. An interesting example of this genetic fundamentalism can be found in Gros (1990: 20) referring to the Human Genome Project. According to Gros, we can reduce vital mechanisms and therefore also human behavior to a 'huge algorithm' whose programme is determined by chromosomes. From this perspective, biology itself should be considered as an information

science and the human body as a kind of complex 'Meccano' whose components are just genetic information. Le Breton is right to warn about the risk of just such a reductionist approach leading to a scientific tendency to deny differences between organisms and species, as well as between the living and not living.

One serious risk we run in following this framework is that of depriving living beings of their *specificity*. As Research Director at the National Centre for Scientific Research (*Centre National de la Recherche Scientifique, CNRS*) world renowned geneticist Bertrand Jordan, someone who certainly cannot be accused of harboring an anti-science attitude, has complained that undisputed advances in biology led some scientists, the media and public opinion to overestimate the power of genetics (Jordan, 2002). He talks explicitly of a culture of 'genetics mastery', where imposers and fakers can thrive. Scientists contribute to this supposed mastery, he explains, sometimes from imprudence and sometimes for other interests, occasionally immoral. Inherently sensationalist, the media also contributes to laud genetics through oversimplification, which further distorts the distortion. Nevertheless, new routes leading to other visions and perspectives have been opened.

3.3. The epigenetic turn

The gene-centric reading of life has increasingly been challenged over recent years, within biology itself as well as by philosophers of science. Gradually, a new way of looking at the role of the genome in life processes, based on alternative assumptions, has appeared. These new assumptions have been tracing a two-step conceptual flow that challenges the genetic dogma. The first step moves from the idea of the isolated genome to the idea of its relationships with the living organism, the second from the living organism to the interrelations of this with the external environment. What is crucial here is that this flow is not unidirectional, but circular, in the manner of a feedback loop.

3.3.1 DNA as a plastic entity: the organism – environment mutual interchange

Many scholars started to feel dissatisfied by the hegemonic gene-centric approach and started to take a different direction, over the last three decades, stimulated by the

pioneering work of Conrad Waddington. Waddington's laboratory empirical research showed that some somatic non-inherited changes provoked on phenotypes by environmental stimuli can be genetically assimilated and transmitted to following generations even when the stimulus which generated them is no longer active[52]. The traditional epistemological divide between inside and outside was radically reconsidered by the implication of this work and perceived as a simplistic vision.

In the traditional, the organism is read as the passive meeting point of independent external and internal forces, whereas, it appears, the relationship between living organism and environment is much more a process of mutual dependence and feedback, of co-construction, in which the organism plays an *active role*. The environment, therefore, is a space importantly defined by the activities of the organism (Lewontin, 2004: 46). This implies:

1) Organisms may search for or select micro-habitats or habitats with specific physical conditions;
2) Organisms are active players in building the world they inhabit;
3) Organisms can survive by altering their environment, consuming the resources they need for this;
4) Organisms are highly sensitive to cyclical changes in their environments.

It follows from this, therefore, that organic life is a *process* importantly based on the transformation of the environment, a transformation that is continuous and retroactive. The transformative change causes reactions in a round of continuous change, a perpetual, *interdependent process of co-construction* involving organism and environment (which, of course, includes other organisms). For this reason, Lewotin suggests that organic processes cannot be understood simply within universal explanations: they have *historical contingency*.

[52]Fundamental here is the fact that the genetic mutations are not random, but environment-oriented or pheno-centered: that is, genes serve the organism within a specific environment.

Within this biological 'new wave' also appears another alternative way of *understanding the process of selection*. Many scholars share the idea that we live today in a post-genomic era, a period in which the central dogma of 'one gene, one protein' (the one-to-one model) is unquestionably in crisis. Adherents of this view emphasize that we need to talk about '*smart changes*' produced by cells and that we have much empirical evidence and a (revived) theoretical basis for depicting the genome as a *plastic entity* and an *integrated complex system*. They recognize a newly important and creative role for the organism-within-an-environment, one that ultimately collapses the traditional nature-nurture dichotomy.

3.3.2 Phenotypic plasticity, epigenetics and the emphasis on the development process

Within the one-to-one model and gene-centric approach there has been an underestimation of various phenomena, including notably:

1) Pleiotropy (one gene affecting several traits simultaneously);
2) Epistatis: (genes affecting other genes, giving shape to complex genetic architectures affecting a trait);
3) Redundancy (different triplets specifying the same amino acid).

Rather than underestimating and even neglecting these phenomena in the reading of the genome, scientists over the last three decades have increasingly been emphasising the importance of *phenotypic plasticity*, the '*property of a given genotype to produce different phenotypes in response to different environments*' (Pigliucci, 2001:1). Contrary to the linear geno-phenotype relationship, this suggests a dialectical relationship between genes and environment. But what is really revolutionary here is the combined effect of two concepts: *phenotypic plasticity* and *epigenetics*. As Massimo Pigliucci (2001) emphasizes, the epigenetic interpretation of phenotypic plasticity makes *development process* the crucial node in the genes/environment dialectic.

A consequence of this new way of understanding the relationship between organism and environment is that geno-phenotype interactions are also differently conceived. For example, Mary Jane West-Eberhard (2003: 16) claims to 'adopt a phenotypic definition of

selection'. West-Eberhard explicitly links species differences and new phenotype creation to the reorganization of 'ancestral phenotypes' (developmental recombination) and the consequent 'genetic accommodation' of change. In fact, she states, selection does not act directly on genotypes, but affects phenotypes first (West-Eberhard, 2005a). So, novel traits can originate through environmental induction as well as mutation (for example, as a side-effect), and then undergo genetic accommodation and selection. Moreover:

> If the resultant phenotypic variation has a fitness effect, that is, it correlates with the survival or reproductive success of the affected individuals, then selection (differential reproduction of individuals or other reproducing entities with different phenotypes) occurs. If the phenotypic variation has a genetic component, selection leads to 'genetic accommodation', that is, adaptive evolution that involves gene-frequency change. Genetic accommodation of regulation adjusts the frequency, timing, and circumstances of the novel response (e.g., by adjusting the threshold for its expression), and genetic accommodation of form refines the characteristics and efficiency of the newly expressed trait. (West-Eberhard, 2005b: 6544)

Insofar as phenotypic novelties arise in this approach from adaptive developmental plasticity, they cannot be considered as 'random'. More precisely, according to West-Eberhard's research evidence, phenotypic accommodation is a specific adaptive adjustment, within which we cannot find genetic change. This adjustment follows new input during development and may start adaptive (Darwinian) evolution in a new direction. What is really important here to emphasize is that the argument that, contrary to common belief, *environmentally initiated novelties may have greater evolutionary potential than mutationally induced ones*. From this perspective, genes are seen 'more as followers than leaders in evolutionary change' (West-Eberhard, 2005b: 614).

Another important contribution to the epigenetic approach to the genome has been made by Eva Jablonka and Marion J Lamb through their book '*Evolution in Four Dimensions*', in which the gene-centered version of Darwinian theory makes way for an analysis of inheritance as determined by four dimensions (four systems): genetic, epigenetic (cellular transmission without DNA mutation), behavioral and symbolic (language and communication). Named the Epigenetic Inheritance System (EIS) – referring to the transmission of information from a cell or multicellular organism to its descendants *without* that information being encoded in the nucleotide sequence of the gene - this

certainly seems to represent a radical alternative to neo-Darwinism rather than just an extension of the Modern Synthesis[53]. Combining Darwinism, Lamarckism[54] and Punctuated Equilibrium Theory[55], EIS drives genetic selection, it is suggested, producing mutational biases and moving towards systemic mutation. For Jablonka and Lamb, developmental and evolutionary adaptation are not always the expressions of opposite paths.

While it is true that development implies *instruction* and evolution implies *selection*, certain inherited variations are clearly controlled by physiology and development.[56]Jablonka and Lamb suggest that, except for few cases, *all* specialized cells (liver, skin, kidney, etc.) are differentiated on the basis of epigenetic differences. Although they have the same genetic information, they work differently. It is *the specific developmental history* that determines which genes are active and how their products will interact (Jablonka & Lamb, 2007: 140). What is really important in the argument here is that several specialized cells are able to transmit their phenotype to their daughter cells without changing DNA sequences.

Jablonka and Lamb describe four different types of EISs: self-sustaining loops[57], structural inheritance[58], the chromatin-marking system[59] and RNA interference (or the 'silencing' of

[53] It could be useful remember that what we consider today as Darwinism is a re-interpretation of his ideas in the light of population genetics and Mendelian inheritance, a new theory dubbed 'neo-Darwimism' or the 'Modern Synthesis', the latter originating from the title of a 1942 book by Julian Huxley (grandson of Thomas Huxley) *Evolution: The Modern Synthesis*. Probably even Darwin himself would have not appreciated the radical marginalization of Lamarckism characterizing this interpretation.

[54] The principle according to which an organism can pass on characteristics that it acquired during its own lifetime, also known as heritability of acquired characteristics. It is named after the French biologist Jean-Baptiste Lamarck (1744–1829).

[55] A theory which proposes that most species will exhibit little net evolutionary change for most of their geological history, remaining in an extended state of *stasis,* and that significant evolutionary change is generally restricted to rare and geologically rapid events of branching speciation named 'cladogenesis'.

[56]For example this is the case of the so-called *alternative splicing.* Here we have a process by which a single DNA sequence is able to produce different mRNA and, by consequence, multiple proteins. In the alternative splicing, the environment and the developmental conditions determine which polypeptide will be set. At the same time, several cells are able, with the help of specific enzymes, 'to cut and paste' RNA and DNA itself.

[57] A temporary stimulus induces a gene to be active, and its product induces the gene's activity. This is a model in which A produces B and B produces A within a feedback system. Daughter cells inheriting the gene's product reproduce the active state.

[58]Here the existing structures of some cells can mould similar ones in daughter cells. It is the membrane *organisation* to be modified and transmitted. Some pathogen agents are, in fact, self-modelling, famously the prions in Bovine Spongiform Encephalopathy (BSE) and Creutzfeldt-Jakob disease (CJD) in human beings.

[59]Such as the DNA methylation enabling gene activity or inactivity states which are then transmitted in cell lineages.

the genes)[60]. Following the lead of many microbiologists, Jablonka and Lamb believe that the EISs presently known are only the 'tip of a very large iceberg' (Jablonka & Lamb, 2007 : 172). This claim may be overemphatic, but to support the idea they do present some very interesting cases of methylation[61] able to cause inherited phenotype variations both in vegetal (*Linaria vulgaris*) cases and mammals (Whitelaw's mutant mouse strain[62]).

Epigenetic Inheritance Systems (EISs) are both onto-genetically and phylo-genetically relevant. They play a key role within development (ontogenesis) and within evolution. For this reason, it is possible to use the neologism '*evo-devo*' to indicate processes they imply and to start thinking about a new way of reading and living life.

3.4 Re-reading the genome as a place of potentialities, illustrating the creativity of living systems

The philosopher of biology Susan Oyama appears to have excellently interpreted the new mood. Her 1998 work referred to present a radical re-interpretation of the concept of ontogenetic development as well as of biological evolution in general, adopting a view considering *development as the intersection of many interconnected levels*. Oyama proposes an exit from traditional oppositions implied by the nature-nurture binomial, defining each system as a 'natural-cultural' as well as 'environmental-genetic developmental system'. In fact, following the experimental evidence collected even by the end of the 90s, she re-conceptualizes the genome, presenting it not as a barrel – full of discrete units of linearly interconnected information (genes) – but as an integrated system, a non-linear multilevel network related to cells and organisms. From this perspective, the genome is a '*place*' of potentialities influencing the developmental process with different modalities in a context-dependent fashion. The genome is precisely the place where, contrary to common wisdom, living systems show their *creativity*.

[60] Named 'RNAi', this is an EIS able to bringing about stable and inherited gene silencing: some abnormal RNA molecules are recognised and chopped by a special enzyme (dicer) and the resulting fragments (siRNA) are able to eliminate the mRNA abnormal copies through methylation or a protein mark (Jablonka & Lamb, 2007: 166).

[61] In chemical sciences it is a form of alkylation (a methyl group in addition to a substrate). In biology it can be generated by enzymes.

[62] In this famous experiment on mice led by the Australian geneticist Emma Whitelaw, it was showed that phenotypic variations of fur occurring in genetically identical mice were transmitted to offspring, a process linked to methylation patterns passed on to the next generations through the eggs

Oyama supports her thesis referring to the Developmental Systems Theory (DST). In such a system, there is no room for the body/mind or nature/culture dualisms. These are not regarded as pairs of somehow 'interacting' entities because this interaction logically assumes a (prior) differentiation between these *as* distinct. Here, on the contrary, development is seen as an '*interactive emergence*', wherein the system is self-organized, and the 'self' not a *primum mobile* but an *entity-with-its-world.*

Fundamental to the DST approach is an emphasis on the need to shift the focus of analysis from processes of information transmission to the never-ending co-construction and co-transformation processes. As pointed out by Kim Sterelny (2001), and in line with Lewontin (above), for DST, inheritance and learning are coupled concepts delineating interactive resources transforming entities and contexts throughout lifecycles. Furthermore, because the relationship between information and ontogeny is inverted within DST (and by Oyama), the (genetic) *programme* metaphor – 'explicitly identified as the genome', as Evelyn Fox Keller (2001: 303) noted – loses its misleading power.[63] It is individual ontogeny that gives pertinence to information. Development is the primary datum. This is a new paradigm, which implies a radical shift to a focus on individual process and contingency. Contingency does not mean unpredictability, however, as it here has an *ontological* sense: it is a special case of causal determination.[64] In developmental systems, in fact, we register a very high degree of contingency amongst different levels of causal determination – which, paradoxically, produces predictable and repeatable but, yet at the same time, not necessary or ineluctable trajectories.[65]

Development is thus reconceived asa game between internal constraints and external potentialities. This game makes life creative and flexible. This ambivalent quality of developmental systems makes life processes both reliable and unpredictable, at the same time. This is what Oyama (1998) means when she says the developmental systems are 'ordered', but not 'pre-ordered'. Oyama's work – as well as that of Lewontin (1993) and

[63] Like the metaphor of information (above 1.1) this also was borrowed from (early) computer science, according to Evelyn Fox Keller, introduced by Mayr (1961) and Monod and Jacob (1961).
[64] For example, the imaginal disc gives rise to an insect limb or wing largely through the growth and unfolding of a pre-patterned epithelial layer, but, during early development the disc is created by means of multiple, complex interactions.
[65]Deconstructing the nature/nurture dichotomy, Oyama presents a view in which ontogenetic cycles employ a set of heritable developmental resources. Each generation reconstructs them activating a process very similar to what Maturana and Varela (1980) called 'autopoiesis'.

Patrick Bateson (1988) – anticipated a very rich and influential avenue of research. From the socio-anthropological perspective, probably the most relevant track to emerge from this, is the so-called 'ecological niche construction approach', in which an ecological inheritance is emphasized alongside the genetic (Odling-Smee et al., 2003). This is highly pertinent here, since it displays an important parallelism between development paradigms both within biological and social processes (see below).

3.4.1 The Ecological niche construction approach: re-discovering ecological inheritance

Where Jablonka and Lamb proposed four distinct inheritance systems in evolution (above 2.2), Odling-Smee et al. (2003) delivered a new momentum to Lewontin's teaching, with their proposal of two general inheritance systems in evolution: genetic inheritance and ecological inheritance. Starting from Waddington's fundamental assumption, according to which organisms are not passive agents obliged only to react to external local selective pressures, Odling-Smee and colleagues argue that organisms are active agents perturbing and selecting (with metabolisms, movements, behaviors, choices, etc.) their own habitat (niche). That is, plastic phenotypes are able to change the natural selection pressures of local environments simply because they have to use resources from their environments through non-random work in order to stay alive. These changes can 'act back on the phenotypes, and on their offspring, and very likely, on other related organisms too, with 'better' or 'worse' consequences for the genetic fitness of all these organisms' (Odling-Smee, 2002: 165).

According to this view, ancestral organisms transmit to their descendants not only genes but also an *ecological inheritance*, that is, the inheritance of natural selection pressures modified by the localized environmental construction activities of organisms. This represents a mix of i) independent sources determining the generalized environment and acting on the organism (e.g. climate, the activities of other organisms), and ii) behavior by the organism acting on the environment that creates specific (favorable) conditions. The evolution of organisms, in other words, depends on a combination of natural selection and niche construction.

According to Paul Griffiths (2001), ecological inheritance is a phenomenon that goes beyond the so-called 'Baldwin effect'.[66] He argues that natural scientists continue to show a great interest in the Baldwin effect because they believe that without genetic traces, the epigenetic inheritance cannot leave a significant evolutionary contribution. Griffiths, however, counters that this belief is mistaken and that the Baldwinian heterodoxy of social heredity finds in ecological inheritance theory a very good 'epigenetic' continuity. There are at least four reasons for differentiating ecological from genetic inheritance (Odling-Smee, 1988): it is transmitted by an external medium, the environment; it does not imply the transmission of discrete replicators; it involves several organisms (not only two parents) within and between generations; and it does not involve only genetic relatives, but all organisms sharing a specific ecosystem (with an ecological relationship). In the words of Luca Cavalli-Sforza, ecological inheritance may be 'vertical, horizontal or oblique' (Odling-Smee, 2002: 178) – which leaves him to propose a revised socio-biological approach based on a model of organism-environment co-evolution.

Human culture is, of course, located within these niche construction processes. Here, the human modification of natural selection pressures are regarded as a part of a more general 'heredity' of modified selection pressures caused by the niche modification action of constructing ancestors. Culture, from this perspective, influences genes in two ways. Firstly, it influences differential survival and reproduction, as already assumed by human behavioral ecologists or, in a richer version, the gene-culture coevolution theorists (e.g. Cavalli-Sforza & Feldman, 1981). Secondly, it contributes to niche construction. From now on we thus have to include within the human ecological inheritance the culturally modified natural selection pressures, artefacts included.

3.4.2 Exaptation and the organism as a "bricoleur"

Within this alternative post-Darwinian framework we also find an important reassessment of the concept of *exaptation*. This concept has a long history dating back to 1872, when Charles Darwin responded to the zoologist George Mivart's objections to the presumed

[66] Theorized by the American psychologist James Mark Baldwin, this describes a character change (acquired or learnt behaviour or skill) occurring in an organismas a result of its interaction with its environment and becoming gradually assimilated into its developmental genetic repertoire.

inability of natural selection to account for the incipient stages of particularly complex biological structures. Darwin used the neologism '*pre-adaptation*' and introduced the possibility of *redundancy* in nature within the relationship between organs and functions. Darwin envisaged this redundancy as allowing for traits developed for particular reasons to be co-opted or converted for new and independent functions – a functional co-option dubbed 'exaptation' by Gould and Vrba (1982), to indicate how organisms often opportunistically re-adapt available structures for new functions.

It is interesting to notice that the concept of *exaptation* evidences an interesting analogy between organic and technical change. It shows, in fact, that new structures in nature do not appear from nowhere, are not designed for a specific aim '*de novo*': 'natural selection can only work on the stock of materials that are already available' (Ingold, 1997 : 119). Changes within an ecological niche can lead the organism to co-opt one structure evolved for a specific aim to do a quite different job. In this view, therefore, the organism is considered as a sort of 'plastic' *bricoleur* which faces change by putting to the best use that of which it already has[67]. In this sense, flexibility is the main strategy available to the organism in order to guarantee its survival, and this is enabled by imperfection, multiplicity and redundancy (Pievani, 2004).

Patrick Bateson (1988) goes further on this fundamental aspect. He shows that the traditional Darwinian image of selection leads to a concept of evolution downplaying the role of organisms within the evolutionary process. Indeed, Bateson considers the Darwinian metaphor of the 'external hand', as well as the Darwinian image of 'selection', as 'encumbrances'. He describes four characteristics that valorize organisms:

a) Choice making that can influence the course of evolution;
b) Actively alteration of their physical and social environment condition;
c) Adaptability;
d) Alteration in gene expression.[68]

Bateson is very critical of evolutionary theory considered as 'the tendency to place so much emphasis on genes as the units of evolution and so little emphasis on how they are

[67]This principle of *bricolage* is, of course, valid also at the micro-level, as claimed by Jacques Monod (1977).
[68] See the 'genetic assimilation' (Waddington, 1953).

expressed', preferring instead '*behaviorally induced evolutionary change*' (Bateson, 1998: 192).He thus present a picture in which developmental processes are not considered merely as constraints but also as evolutionary resources. [69] Patrick Bateson effectively calls for new metaphors able to replace the old Darwinian ones that emphasize the central role played by the relationship between the *organism-as-a-whole* and the environment in *life processes*.

3.5 Conclusion

The main aim of this chapter has been to consider the possibility of *a bio-anthropological link that can explain and justify the importance of experience in human culture and an epistemological paradigm able to represent such link in the life sciences.*

Epigenetics appears to represent such a bio-anthropological and epistemological link, which is how it shows the organism as biologically founded on a radical openness to and interaction with the external world. There is no need, how it is often done, to refer to biological pre-defined instructions (genes) as the key-instruments for life development. Since this biological openness establishes all the dimensions of life (including the psychological and social life). Ultimately, there are no pre-defined informational codes determining human life.

The philosopher of science Lenny Moss argues that paleoanthropology and comparative genomics show that the new passwords of biology are *flexibility* and *plasticity*: in fact, no organisms are limited to single-response patterns, albeit with varying degrees of freedom (Moss & Pavesich 2011: forthcoming). An organism's activity is multi-contingent, which is to say that it can and must develop complex mediated relationships with its environment. Unfortunately, however, generations of young scientists have been educated in the dogma according to which the appearance of biological novelty is just assumed to be due to random and accidental genetic mutations, with no room for the creative or adaptive powers of individual organisms in specific settings.

[69] The anthropologist Robert Foley, explicitly inspired by Bateson, used this very explanatory sentence: 'behavior, particularly the social one, which usually goes beyond the scope of paleo-biology, is essential to understand evolutionary events' (Foley, 1999: 233).

The power of this dogma is revealed by the extensive resources employed for the development of the so-called Human Genome Project (HGP). We are probably now in a position to conclude that the high expectations generated by the HGP were dramatically betrayed. The scientific dream of associating individual genes with distinctive functions has long been forsaken: humans have no more of genes than other mammals, and fewer than some, and barely any more genes even than a microscopic rudimentary invertebrate like a flatworm. Clearly 'the gradual emergence of behavioral complexity was not achieved by accumulating genes', as Bateson (1988: 201) puts it.

With a range of theories and evidence re-interpreting the role of the genome in life processes, the emergence of a new theoretical framework (a new paradigm) in the life sciences as presented here moves us from a rather deterministic, mechanical, and ultimately dualistically based evolutionary model towards an emphasis on active, reconstructing organisms and the organisms/environment interrelationship in development. This paradigm, presenting DNA as a rich plastic landscape and showing the biological capacity of the organism to react creatively to environmental changes (which are often ontogenetically self-produced) demonstrates that organisms do not have a *specified* design encoded in their genome or, at least, as Tim Ingold states, there are no means for 'reading off' this specification from DNA:

> There is only one reading of the genome, and that is the process of ontogeny in itself. Hence there can be no design for the organism other than its actual phenotypic form, as it emerges within particular developmental context. (Ingold, 2000: 233)

This post-Darwinian interpretation of life supports a *bottom up* ecological model that is able to avoid both the limitation of genetic determinism. But what is important for us, as social scientists, is that this epistemological change in the life sciences has some important implications which can help social sciences also to renew their epistemological basis.

Following Ingold, the currently hegemonic interpretation of man may be analyzed as based on the alliance of three complementary intellectual paradigms sharing the same informational fundamentalism and supporting one other : neo Darwinism in biology, cognitive science in psychology and cultural theory in social sciences. These approaches

clearly share the same epistemological basis, namely formal instructions (information) embedded within the body (genes), the mind (memes) or the society (norms).

Human culture here is considered as a set of rules and representations available for transmissions across generations independently of their practical application (the so-called 'cultural models' or 'schemas'). In this conception, culture is supposed to be detached from experience, 'just as [the] organism genotype is unaffected by the vagaries of its life history' (Ingold, 1997: 239). Against this, still following Ingold we can refer to ecological psychology (Gibson, 1979) and the anthropology of practice (Bourdieu, 1972) to claim that knowledge, rather than being imported by the mind (as cultural *design* or *programme*), is itself generated within the contexts of experience during people's involvement with the surrounding natural/social environment. Moreover, knowledge is associated with *skills*: a knowhow that we carry in our bodies with no formal instruction but through a repetition of performed and embodied (read *enfolded*) tasks. From this perspective, skills and experience are basic interfaces between organism and world (see Table 1).

Table 1

	Life as informational design or programme	**Life as a process with no specified codes**
Biology	Genetics	Epigenetics
Psychology	Cognitivism	Ecological psychology
Anthropology/Sociology	Culturalism	Socio-anthropology of practices

Similarly to what has been suggested for the genome in the epigenetic interpretation of life, the body can be considered as an organism with no *specified* cultural design encoded in the mind. Contrary to informational determinisms, we believe that the body, facing processes of growth and decay, enfolds in its anatomy (musculature, neurology, etc.) particular 'skills, habits, capacities and strengths, as well as debilities and weakness (Ingold, 2000: 239). Then, it becomes really difficult to separate the cultural from the biological. Indeed, the epigenetic idea of the organism scientifically supports a bio-socio-anthropological idea

of man as a real *being-in-the-world* - the *organism-person* in Ingold's terms.[70] This is an intentional body living in reciprocal relationship with the surrounding environment.[71] In this direction, Alvin Noë (2010: 25) claims that the best of science and philosophy in the future will lead us toward a vision of ourselves as beings endowed both with bodies *and* world; while Leila Craighero (2010), from the neurosciences, calls for an overturning of the Cartesian principle leading to the claim, '*sum ergo cogito*'. Our knowledge of the world is deeply linked to its translation in our experience in the first person, she says. It is precisely because we are *acting beings* that we are also *thinking beings*.

Lenny Moss (2009) moves in a similar direction. According to Moss we live within '*ecologies of compensation*', where the central role is played by the complex processes leading to the acquisition of skills.[72] Indeed, the achievement of any constructed niche (nest, tunnel, culture, etc.) constitutes a resource for 'compensatory stabilization', where *skills* assume the relevant position of a field of analysis promising to be fertile and fruitful for interdisciplinary research (Sigaut, 1994). For all these reasons, Ingold, again, calls for a 'relational thinking' in biology and the social sciences. This means:

> […] treating the organism not as a discrete, prespecified entity but as a particular locus of growth and development within a continuous field of relationships. It is a field that unfolds in the life activities of organisms and that is enfolded (through the process of embodiment or enmindment) in their specific morphologies, powers of movement and capacities of awareness and response. (Ingold, 2000: 244)

It is also interesting to notice that this vision is also supporting new lines of study in technology development. In the field of Artificial Intelligence (AI) and Life (ALIFE), for example, the first wave of studies reproduced the dualistic and informational paradigm we

[70]The locus of intentional agency, in Ingold's work is the *person.* '[E]very organism is an open system generated in a relational field that cuts across the interface with the environment. For the developing human organism, that field includes the nexus of relations with other humans. It is this nexus of social relations that constitutes him or her as a person. Thus the process of becoming a person is integral to the process of becoming an organism. […]The human being, then, is not two things but one' (Ingold, 1989: 220).

[71] It is interesting to note that this is an uncommon case in which the hard sciences can help humanities to support a philosophical tradition, that of phenomenology.

[72]These constructive phenomena have until now been incomprehensibly neglected, but today many ecologists and ethnologists are giving new relevance even to animal architectural skills, considered as a form of *ecosystem engineering* (Gould & Gould, 2007).

criticized here, incorrectly assuming that an artificial production of mind would be enabled by a reproduction of the formal and 'syntactic' interpretation of intelligence. Today, new perspectives prefer to look at the relationship amongst the brain, the body generating that brain and the physical environment with which those organism interact.

Epigenetic Robotics (DevRob) and Behavior-Based-Robotics (BBR), manage intelligent behavior excluding the meticulous planning and implementation of a coherent conception of the world through the formal description of the totality of objects and the possible environmental conditions. Here, the robot learns and (re)produces skills through experience, by doing, through trial and error repetitions and using information collected in the field to react to environmental challenges. The new buzzword of robotics are thus the same as those in the case of the 'real' biological organism: situatedness, embodiment, emergence (Vidal, 1997). Evidently, the focus of the attention is displaced from the machine in itself to the particular relationship that the machine has with its environment.

And we find similar trends also in the field of agro-biotechnology. The *top-down* model, based on the imposition of 'abstract' seeds created in the labs by high-knowledge networks of research financed by big corporations and up-rooted from the environment in which seeds grow has led both to agronomic failures and dramatic social inequalities. Today, participatory strategies are being developed that lead to a *bottom-up* ecological involvement of *(re)skilled* local farmers (together with scientists and technicians) that involve the selection of seeds by crossing traditional knowledge with technological development in their local natural environments (Ruivenkamp, 2008; Ruivenkamp et al. 2008). The general assumption is, again, that we can improve seed selection and socio-economic relations by interacting with natural/social local environments.

For all these reasons, the epigenetic interpretation of life is not only to be considered a 'matter' for biologists, but also as a potential new paradigm able to support the humanities and social science. In the following chapters, I will try to develop this interpretation into social analysis, referring specifically to technique (and then technology). I choose technique as privileged point of view, because it is the most emblematic example of our interchange with the world in which skills and experience play a fundamental role and, at the same time, in which this role is neglected.

Chapter 4

Symmetry and asymmetry between body and tool: from technique to technology[73]

4.1 Introduction

The opposition between utopia and dystopia (e.g. Galimberti, 1999; Feenberg, 2010; etc.) or 'apocalyptic and integrated' (Eco, 1964), has often characterized philosophical and anthropological debate on the issue of technological development (similar contrasts may also be found in current public debate).[74] In the context of scientific literature, there are various (techno) pessimistic readings grounded in what we might define a 'regressive' interpretation of the Man-Technology relationship.[75] One implicit, though sometimes explicit, assumption of such readings is the notion that the advent of technology in modern society has caused the deterioration of the relationship between perception and action. Particularly, within non-dualistic currents of philosophy, psychology, biology and anthropology looking at the body/mind relationship, there is a wide consensus that action and body perception are two sides of the same coin.[76]

It has often been assumed that modern technology would radically mediated human action provoking a degradation of the direct body perception of reality. This process has been

[73]This chapter is based on the content of the article: G. Nicolosi (2012), Corpo, ambiente, tecnicità. Azione tecnica ed esperienza tra Ragni e Formiche, *Tecnoscienza. Italian Journal of Science and Technology Studies,* 3(1), pp. 73-93.

[74] Various investigations have shown the difficult and controversial relationship of Italians with technology. Often fluctuating between acritical enthusiasm and profound scorn. Similar contradictions have been found at a European level by the Eurobarometer surveys (Bucchi & Neresini, 2006; Nicolosi, 2006).

[75] Exemplary though very varied cases of techno-pessimism include the ideas of Heidegger, of authors of the Frankfurt School and, more recently, Postman (1993) and Nikolas Kompridis (2006). An extreme and violent version of such a formulation has recently generated a subversive and terrorist social and political phenomenon called 'Neo-Luddism', the most renowned exponent of which being Theodore J. Kaczynski (2010), the infamous "Unabomber".

[76] Equally cognition is not to be considered as the ensemble of abstract encapsulated symbols in the mind but as the ontogenetic development of perceptuo-motor skills (Neumann & Prinz, 1990). These approaches have strongly influenced new perspectives in artificial intelligence (AI), such as epigenetic robotics (Morgavi, 2011).

considered as the core issue of the so-called autonomy of technology from human and social skills, and has often been taken to the point of postulating an absolute separation of material reality from bodily experience with catastrophic psychological and social outcomes (e.g. Virilio, 1988; Baudrilliard, 2005). An important element of this interpretation may be traced back to the deeply rooted epistemological union between mind/body dualism (Le Breton, 1990) and an 'instrumentalist' prejudice in defining modern Western thought, meaning by 'instrumentalist' prejudice the tendency to interpret technical action in the light of a presumed 'dependency' of the human player on the mechanical instrument.[77]

Often spilling over into a genuine technological determinism, the dystopian dependency thesis has characterized the debate on technique ever since the advent of industrial society (Bourdon, 2001).[78] It has contributed to reinforcing a substantial conceptual identification of 'real' work with manual labour alongside a generalized conception of mechanical work as alienating and expropriating. In this picture, the process of progressive mechanization of work has inevitably been interpreted as a dangerous erosion of the creative and constructive abilities of the human actor.[79]

The advent of electronic and digital technologies has convinced many of the soundness of the pessimistic view. One often speaks of cyberspace today in order to regret the loss of the ability to explore the physical and the solipsistic closure of the body in the virtual world artificially generated by machines (Barcellona, 2005) - a regression that would deny the encounter between the material and man and the authentic possibility of a 'handicraft' experience of the world, severely reducing the margins of real, innovatory human labour.

[77] The classic body/mind dualism is a two steps prejudice, withbody and mind firstseparated, and then the body made mind-dependent (Le Breton, 1990).The instrumental prejudice follows the same schema with a separation between human player and mechanical instruments actor followed by human dependency on the mechanical.

[78] In the history of social thought, an emblematic case of instrumentalist prejudice is represented by the analysis of Karl Marx in his political writings such as the *Manifesto*.

[79] According to Ingold (1999), representing this in a specifically socio-anthropological context is André Leroi-Gourhan's *Le geste et la parole* (1964), which lays out an evolutionary path tracing the origin of technicity to the 'liberation' of the hand in the process of the phylogenetic development of *Homo sapiens*. Leroi-Gourhan presents an interpretation of the relationship between hand and technique that, I would argue, anticipates a principle that was to directly and indirectly influence generations of scholars: the obsolescence of the body (Capucci, 1994; Maestrutti, 2011). An apparently paradoxical aspect of this –revealing, in fact, the profundity of the principle - is that it is also shared by opposing 'factions' like the techno-pessimists and the post or trans-humanists (e.g. Stelarc, 1994; Moravec 2000; Warwick, 2004; Kurzweil, 2005; Hugo de Garis, 2005; Bostrom, 2002).

In contemporary society, human experience does indeed seem to be largely reduced to the consumption of goods by consumers who no longer participate in the technical production of reality.

The objective of this chapter is to highlight how the pessimistic socio-anthropological analysis of technique could be the consequence of an erroneous standpoint and thence to indicate a more articulated interpretation of the role of technology in the contemporary world. The main aim here is to answer the following research question: what kind of socio-anthropological data can help us in understanding if the relationship between corporeal experience and material reality is still relevant in defining the idea of technicity[80]? Should we really consider the innovative and skilled handicraft experience of the world to be something relegated to a distant past?

In trying to give an answer to these questions, an ecological and pragmatist view is assumed that defines technicity as an interweaving between organism (the body), tools and environment. Crucially, at the very centre of this interweaving a key role is still played by the human experience, that is, by skills. This is explicate in following two sections. Against the dystopian dependency thesis, it is argued that this interweaving is not being - cannot be - broken by the advent of modern technology. The final two sections show why, or how, skills do not disappear in modern technology.

The strategic aim of this chapter is to continue with the line of arguing established in the first chapter, by showing the relevance of human experience and skills in technical action. As stated (chapter 1), we decided to eviscerate this issue in a threefold analysis. Moving from the bio-anthropological ground-laying level of analysis of chapter 2, which brought us to the point of human culture, attention now moves squarely to the issue of man and his place in the world with a review of socio-anthropological considerations.

Assuming, thus a socio-anthropological perspective, this chapter engages with the following key issues. First, I seek to define technicity with reference to the intimate and

[80] The English neologism of technicity here is used to indicate that dimension of identity and experience linked to the subject's relationship with technique/technology'. At the end of the chapter we will arrive to re-define this experience as characterized by 'the particular alignment (tuning) between corporeity, the situational context, the material and tools used'.

indissoluble interweaving between organism and environment. Then, I characterize technical action as defined by the frame of the ecological perspective of Tim Ingold, in the sense of an emergent property of the whole process, synergistically, that is, involving gestures, tools and material in a determined space and time of a real *being-in-the world*. The next section makes a theoretical digression aimed at showing how the ecological perspective adopted here may conflict with *Actor-Network Theory.*

The penultimate section shows how the centrality assumed by the concept of skill in defining technical action as adopted may, in new forms, be combined validly with reference to advanced digital technologies. The chapter concludes this with a reflection on the responses to the research questions outlined, and indication of issues to be investigated further for the development of a socio-anthropological approach to technology development.

4.2 Intentional acting as integral aspect of the relation between organism and environment

> *At the outset of the study of perception, we find in language the notion of sensation, which seems immediate and obvious […]. It will, however, be seen that nothing could in fact be more confused, and that because they accepted it readily, traditional analyses missed the phenomenon of perception.*
>
> (Merlau-Ponty, 2002: 3)

From an epistemological point of view, the last few decades we have witnessed an acceleration in the gradual erosion of the consent that for centuries had maintained Cartesian dualism as the dominant model of reality (chapter 2). For, by one of those strange paradoxes which the history of the ideas has by now accustomed us, it is precisely the development of new scientific paradigms (Kuhn, 1962) in life sciences (Jablonka and Lamb, 2007; West-Eberhard, 2003; Lewontin, 2002) and neurosciences (Rizzolatti and Sinigaglia, 2006; Damasio, 1994; Edelman, 1992) that has prompted a significant narrowing of the gap between the sciences of nature and human sciences in interpreting the relationship between organism (human or animal) and environment. In particular, many

scholars consider organism and environment to be inextricably connected by an ecological[81] relationship hinging on two concepts: flexibility and plasticity.

It is ever clearer that the human being appears as *a being-in-the world*, namely an intentional body that lives out a relationship of reciprocity with the surrounding environment. There is a very important tradition of externalist or sensorimotor philosophical studies that leads precisely in this direction (Clark, 2007; Noë, 2005; Jacob and Jeannerod 2003; Varela et al., 1991. In this picture of radical transformations, the socio-anthropological analysis of technique[82] cannot be limited to set out, as so often happens, a museum-like cataloguing of the tools and techniques adopted throughout the several ages and cultures of the world. Rather, it demands the development of a new socio-epistemological interpretative framework.

The British anthropologist Tim Ingold has focused his attention in this direction. Going beyond the classic binomial opposition Nature/Nurture (Oyama, 1998), Ingold refutes the alliance and mutual support of the three complementary informational paradigms (the complementarity thesis) that have hegemonized the contemporary scientific panorama for decades: neo Darwinism in Biology, cognitive science in psychology and culturalist theory in anthropology (Ingold, 2000a). As indicated (chapter 2), for Ingold, man is not the mere juxtaposition of three informative packages: body (genetic information), mind (cognitive information) and culture (normative information). Rather, man is an entity that emerges from the bio-socio-anthropological relationship with the surrounding environment, in the form of an organism-person. Smoothing the sharp distinctions used to separate the domains of social and ecological relations and between the concepts of person and organism, Ingold seeks to demonstrate that intentional acting is found within the person, and that the development of this is integral to the development of the organism, since the organism[83] is an open system generated in a relational field that transversally cuts across the interface with the environment.

[81] Ecological science is a multidisciplinary approach toward studying living systems founded on the analysis of the reciprocal relationship that is established between these and their respective environments. Traditionally, ecological analysis places emphasis on the biological bases of the exchanges of energy between physical environments and animal organisms at various levels (cells, organisms, etc.).
[82] Technique is, par excellence, the anthropological 'medium' with which to 'operate' in the world (Arendt, 1964).
[83] In Ingold's work, the concept of organism coincides substantially with that of body.

Inspired by research into the biology of development, ecological psychology (Gibson 1977)[84], phenomenological philosophy (especially Merlau-Ponty) and by the anthropology of practice (particularly Bourdieu), Ingold identifies the crucial juncture of connection and continuity between the organic and the social in the concept of *skill* (Moss and Pavesich, 2011). For Ingold, the body is an organism that is not bound by any specific cultural or biogenetic design. Rather, having to deal with processes of growth, development and decay, the body enfolds in its organization (anatomy, musculature, neurology, etc.) particular practices, habits and skills that are at once both biological and social (Ingold, 2000a: 239).

Skills may be described as properties of living organisms that consist of posture and gestural expressiveness and which, through repeated exercise, are transformed into a stratified corporeal conformation (Connerton, 1989). This means a tacit knowledge (Polanyi, 1979) that cannot be encoded linguistically or by formal rules and algorithmic procedures (*savoir-faire*). Starting off from this epistemological perspective, Ingold considers technicity[85] a complex process linked to the ecological relationship[86] that is established between the organism and the environment.[87]

[84] Developed by James J. Gibson in order to more fully analyze the relationship between action and perception, ecological psychology had at its core a consideration of the concepts of 'physical' applied to the environment, and 'biological' or 'psychological' applied to the organism, as reciprocally and mutually dependent.

[85] Technicity does not necessarily envisage the presence of a tool. Speaking of technical action only in the presence of a tool is a modernist prejudice, following which the essence of technique would not reside in the skill of the user, as much as in the *corpus* of formal rules that are encapsulated in the technological object (Ingold, 2000b). Mauss (1936) understood this well but his *techniques of the body* was conceived in an excessively individualized manner: an ecological approach, on the other hand, invites us to consider these as the properties of a system of relations that is established between agent (human or non-human) and the surrounding environment (Ingold, 1997: 111).

[86] From this perspective, no clear-cut separation can be made between the technical and social and any such is misleading. Skills are sedimented and transmitted social practices, even if such transmission does not imply encoded representations, because skills are impervious to cultural encoding, just as the organism is impervious to genetic codings.

[87] Technical action is a skilled practice that emerges as a procedure in the course of the development of an attentional, intentional and perceptive involvement of the subject with the object in a defined context. In this process, imitation and innovation are two sides of the same coin (Lave and Wenger, 1991).

4.3 Technical action as a junction of body, tool and skill

> *Demand for dexterity is not in the movements themselves but in the surrounding conditions. (Bernstein, 1996: 23)*

Beginning from this theoretical definition of the concept of technicity and in order to understand what 'acting technically' means in concrete terms, it is essential to define what a tool is. From an ecological viewpoint, an object cannot be considered a tool on the basis of its (presumed objective) attributes. On the contrary, following the so-called 'affordance theory' (Gibson, 1977),[88] an object is only a tool in relationship to other objects within a field of activity in which a certain effect may be exercised. As Francois Sigaut states, criticizing the rather widespread practice among archaeologists and anthropologists to decontextualize the tools of the past without any reference to space-time adaptation processes, 'isolated objects do not tell us anything' (Sigaut, 1993: 383).[89] This de-contextualization is a tendency based on models of analogical reconstruction and, therefore, of teleologically projecting backwards current knowledge and usages.

In the case of tools, the de-contextualization generally occurs because we are accustomed to defining a tool with reference to a presumed *function* that we tie to specific attributes that are considered objective. In reality, as Ingold points out (2006), the so-called functions are mere implicit stories or narrations that, describing the way in which the instruments are used, end up by normatively defining theirs 'correct' use. However, given that the meaning of every narration is neither 'ready for use' nor reinvented each time *ex novo*, the functions of tools must necessarily be recognized by means of a re-alignment (creative) of the meaning of the implicit narration to the actual circumstances that the user experiences. This is why, the expert users (the skilled) are like story-tellers whose stories are narrated by the practice of their technical actions. Tools thus have a procedure-like quality, similar to that of the activities that they make possible.

[88] Gibson's affordance theory asserts that human beings perceive the world not only in terms of the form of objects and spatial relationships, but also in terms of 'possibility of action'.

[89] According to Ingold, this is comparable to the biological processes of exaptation in the functional cooptation realized by organisms in order to 'opportunistically' re-adapt the bio-anatomical structures they already have for new functions (Gould & Vrba, 1982). We discussed this point in chapter 2.

The central point of Ingold's reasoning concerns not so much tools as the role of the body in the framework of technical action. Whether it is a mere 'technique of the body' (Mauss, 1936) or an action mediated by a tool, in both cases the body (the hands, eyes, brain, etc.) is the main subject of the technical action. In this perspective, it is not we who 'use' our bodies as (simplistically) indicated in ordinary language; rather, it is we, hence our bodies, that use the tool or acts technically in the world following the memorized traces of the performances already realized and inscribed (literally) in our corporeal skills. This is central, even if too often overlooked. Indeed, performances are memorized by the body (by its gestural skill), but not by the tool and, therefore, there is a fundamental and irreducible *asymmetry* between the body and the tool (below, section 3.4).

Moreover, as Leroi-Gourhan had observed, it is not only objects that become tools in relationship to the field of activity in which they are collocated; the body and its organs also undergo the same process with a similar outcome. A hand is not an objective 'thing' in itself (notwithstanding the fact that its bio-anatomical structure is a real and concrete fact); it too has a *history* of gestures and skills, one that influences, over time, the structure in a relationship of mutual and indispensable influence.

As described, therefore, using a tool involves combining (not overlapping) stories contextualized by other objects and tools. This is why we never find ourselves dealing with simple tools, but rather we interact with synergistic processes engaging the bodies of practitioners, tools and materials. Nicholai Bernstein (1996) clearly demonstrated that the technical skills of the practitioner cannot merely be traced back to the gesture in itself, but rather to the 'tuning' that is established between gesture, task and the surrounding environmental conditions. It is this tuning that makes up the essence of skill. And this shows us that if intelligence does not reside in the brain, then neither does it reside in the hand. It lies precisely in the technicity, namely in a tuning, which cannot be traced back to an isolated individual (or part thereof). Technicity is, thus, an emerging property of the entire process that synergically involves gestures, tools and matter, in a determined space-time (social), of concrete being-in the-world.

4.4 Ecological perspective vs. Actor-Network Theory

As noted, Ingold clearly affirms the existence of a fundamental asymmetry between the body and the tool. In defining the role of the actor, thus, this principle reveals a delicate point of dissent with the main concern of the school of thought developed in the context of the *New Sociology of Science*: the Actor-Network Theory (ANT). Also known as 'the sociology of translation', ANT is a conceptual frame emerging in the mid-80s from the work of authors like Bruno Latour (1987; 2005), Michel Callon (1986) and John Law (1987). ANT has explored STS-related issues both refusing the naturalistic (realism) and culturalistic (constructivism) interpretations. It aims to show how science is a process of heterogeneous engineering in which the social, the technical, the conceptual and the textual are constantly interwoven and transformed (translated).

In the ANT model the actor ('actant') is any individual or collective agent able to enter or leave reticular associations (networked) with other agents. In this appproach, it is precisely the networkink that defines substance, action, intention and subjectivity and attributes these to the actant, who in himself lacks any *a priori* essence or substance. Simplifying, one of the theoretical foundations characterizing ANT approach is based on the notion that the actors which can be either human or non-human (for example machines or any technical device) as well as singular or grouped, are interconnected and reciprocally defined in a network of relationships. Along such lines, Latour and colleagues emphasise the principle following which the so-called agency would prove symmetrically distributed in a network. Such an assumption, in STS contexts, is also known as the principle of generalized symmetry.

This principle of generalized symmetry represents the chief separation between the approaches of ANT and Ingold - so much so that recently Tim Ingold (2008) has set out a 'counter-model' incorporating the essential lines of the anthropological-ecological approach as outlined (above) and presented, somewhat ironically, with an acronym that also symbolically represents the contrast: hence, ANT was countered with SPIDER, standing for *Skilled Practice Involves Developmentally Embodied Responsiveness*.

4.4.1 *Embodied Responsiveness*

In effect, there are two linked issues that decisively distinguish between SPIDER and ANT. The first concerns the idea of a network. For SPIDER, the ANT representation of an ubiquitous and extended agency through networks of material relations harks back to a 'weak' epistemological interpretation of the relationship between the associated entities. Indeed, and more explicitly, one might argue that for Ingold the concept of network would be unable to conceptually express a true *relationship* between entities, and would be limited to, at most, their simple reciprocal connection. This is obviously no mere terminological dispute. The criticism is substantial and concerns the ability to represent a materiality of the world that is not entirely included (comprehended) in the connected entities (Ingold, 2008: 210). For SPIDER, the threads of its web are woven with the material discharge from its own body and are placed by its own physical movement. In other words, these lines are extensions of the being as it unfolds along the path of life weaving traces in the environment around it. These are the lines along which the being lives, perceives and acts in the world.[90] Continuing with the metaphor, the spider's web is not considered by the spider itself an entity, it is not regarded as an enclosed and distinct object that can be combined or juxtaposed to other objects in order to support a distributed agency.

At the same time, this vision raises the (second) issue of the heuristic capacity of one of the most used concepts in ANT, that of *hybrid*. If, for example, an ant (ANT) were to define the spider-web conjunction as a hybrid entity, able to function as a trap only if supported by a network of other elements (twigs, bushes, grass etc.), a spider might consider all these elements as bundles of filaments that entangle in an intricate and inextricable way other bundles of filaments which are, in turn, the visible tips of unseen, underground and complex root systems. For this reason, Ingold has his imaginary spider say to the ant:

> It is as though my body were formed through knotting together threads of life that run out through my many legs into the web and thence to the wider environment. The world, for me, is not an assemblage of heterogeneous bits and pieces but a tangle of threads and pathways. (Ingold, 2008: 212)

[90] Andy Clark (2008) speaks of '*wideware*'.

Hence, Ingold (2007) prefers the concept of *meshwork* to that of *network*. Borrowed from the French philosopher and sociologist Henri Lefebvre (1974), this does not refer to lines of connection between separate points, but rather to reticular paths traced by living beings. By moving their bodies in space, these interlace and weave an environment that, before being architectural, is above all 'archi-textual'. It is interesting to note that the meshwork structure echoes patterns of development linked to biological processes of a cellular kind (Figure 1).

A radical refection of the symmetry principle derives from this viewpoint. Indeed, only living organisms act perceptively (intentionally) and build lines of relationship. The entities with which Latour builds his hybrids are in effect unities of media in which living beings are immersed. Against this, for Ingold, the 'blanket-category' used by ANT to indicate non-humans generically (animals, plants, machines, etc.) has the epistemological limitation of removing the fact that it is the ability to realize *attentive* movements that qualify the very movement as *action* and the being doing it as the *agent*.[91]

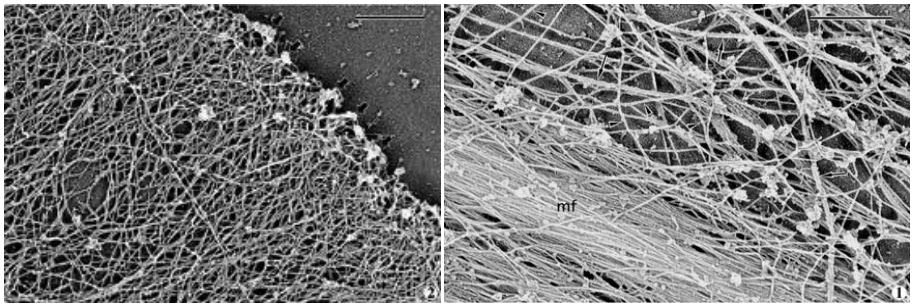

Figure 1. Cellular meshwork (process of differentiation of actin).

The essence of action lies in the intimate interlacing that exists between the body and perception. For the spider, this means that the web is not an object with which to interact, and nor is it an agent in itself. Simply, it is the 'terrain on which it is possible to build

[91] Francois Sigaut (2007) also criticises the concept of negotiation between human and non-human players (short of wishing to interpret the term 'negotiation' to the point of drastically distorting its meaning). Indeed, the relationship with matter demands the 'apprenticeship of necessity' in which there precisely *no* margin for negotiation. This is an apprenticeship that is also laborious and hard, but able to account for the central dimension of technical action: invention. In this, I believe, Sigaut appears to be in line with the pragmatism of Peirce in his radical criticism of the theory of Cartesian *doubt*. For Peirce (the 1932-58), the *genuine* doubt is that generated by action in real life, in which it is the world that takes on the task of constantly crushing the certainties constituting it. Human action is thus caught in the tension between recursive and apparently non-reflective practices, on the one hand, and creative action (skilful problem-solving) on the other.

every possibility of interaction and agency' (Ingold, 2008: 213). Every action is thus always skilled to some extent, and the ability is not founded on intelligence, understood as the capacity to plan and foresee the consequences of the action, but rather on the ability to couple corporeal movements to perception (intention), an ability that is not encapsulated (e.g. in the DNA) and ready-to-use (c.f. the homunculus), but which is developed together with the organism in its interaction with its environment.

4.5 Centrality of skill in technological action

The analytical formulation described could be accused of anachronistically putting forward a romantic approach that is unable to grasp the most radical developments and potential of technological progress brought about by modernity. The processes of *uprooting* and the *abstraction* of work along with the technical action imposed by radical mechanization, and already widely described by classic socio-anthropological literature (Durkheim, Marx, Weber, etc.), seem to leave a very much reduced margin of manoeuver to the skill of man, to his body. The real responsibility of the movements of tools in technical action appears increasingly incorporated in technological *design*, in a serial and unalterable body of rules and algorithms, thus confirming the warning of Leroi-Gourhan about the incorporation of bodily gestures and instruments into the mechanical processes (see also above and note 9).

Nevertheless, as Francois Sigaut has shown with his 'law of the irreducibility of skills', the apparently inexorable separation of action from can never be fully achieved because 'new abilities tend to constantly develop around the new machines (Sigaut, 1994: 446). This 'law' has its roots in a fundamental anthropological relationship between the body and the tool Sigaut (2007).[92] Traces of this relationship seem to go back to the same etymological root of the term 'organ' (of the body), the ancient Greek word *ὄργανον,* meaning 'tool'. Important confirmations of this law come from various theoretical and empirical analyses. From the theoretical point of view, I would mention the highly relevant work by Jacques Perriault (1989). Into his definition of the '*logique de l'usage'*, Perriault has described the dimension of the *technotopo*: an ecological niche of the technological object that, bringing single, instrumental and socio-cultural components together, leads to original lines of

[92] Sigaut speaks of technique as the foundation of human sociability. Indeed, in his view, the mutual relationship between reality, ego and other, which he calls the 'triangle of sense', is created precisely with technical and equipped action (*outillée*). At the root of this action is the *sharing* of experience, which renders technique the source of pleasure and is social in its essence.

thought in his novel interpretation. Regarding the empirical, Caroline Moricot (1997), for example, has masterfully demonstrated how pilots are still engaged in decisively 'tackling' machines with their own corporeal abilities, notwithstanding the high level of automatization of modern airplanes.

There is also, as noted, an important philosophical and socio-anthropological production[93] along similar lines with its roots in the rich American pragmatist tradition (Peirce, Mead, Dewey, James, etc). Succinctly characterized by Hans Joas (2005) as a 'theory of situated creativity', and refuting the analytical theory of (rational) action and its several economic, sociological and psychological derivatives, this firmly refuses to consider the agent separated from his/her particular situational and biographical context. This is precisely what enables the understating of the corporeal dimension of action to trigger the perspectival distortion of the rational theory of action. In the pragmatist view, the body is not a simple *instrument* (of action or communication) always at the disposal of intentionality. It is this same 'instrumentalist' that constitutes the underlying epistemological error with which pragmatists also take major authors like Elias or Foucault to task (Giddens, 1984). On the contrary, bearing in mind the reflection on the body and on intercorporeity (Merlau-Ponty, 2002; Mead, 1934), pragmatism demonstrates how it is not that action is contingent on context but that the context (physical or social) constitutes the action (Joas, 2005: 160).

In terms of the STS debate, it may suffice here to recall, by way of example, the masterful work of Lucy Suchman (2007). Criticizing a certain widespread tendency in the same STS literature to overestimate the rational dimension of the actor/designer and, above all, the ability of the latter to inscribe in the artefact the definition that it has of the user and the use (e.g. Akrich 1992, Woolgar, 1991). Suchman insists that, with respect to artefacts, we are 'embodied users', conditioned more in our usage by the specific, effective and historical contexts than by the scripts codified and inscribed in the technological object.

Finally, drawing on this tradition, the American sociologist Richard Sennett has recently shown that the foundations of handicraft technical creativity (mythologically represented as Hephaestus) can also be rediscovered (with risks and new opportunities) in the

[93] The microsociological research of the Chicago School, of symbolic interactionism, of ethnomethodology and of the analysis of conversation.

relationship we establish with new technologies. In pursuing this line, Sennett has preferred to replace the term 'skill' with that of 'craftsmanship', a highly significant choice that clearly evokes the will of the author to go beyond the risk of a reductive usage of the concept of expert experience (skill). Indeed, craftsmanship is a quality of the relationship that the worker establishes with his task and his activity: tied to 'an enduring, basic human impulse, the desire to do a job well for its own sake' (Sennett, 2010: 18), it cannot be reduced to an exclusively manual activity. Besides, craftsmanship is a quality of work that depends more on the social conditions of the context surrounding the worker than the tools or machinery used – a sociological conclusion that originates in the intimately anthropological relationship (a substantial unity) between hand and head (material body and abstract reason).

Sennett shows that intellectual work must likewise deal with the same practices characterizing manual labor: working with endurance and ambiguity, coordination and collaboration, 'prehension' and concentration, and so on. These, he argues, emerge phylogenetically and ontogenetically from the development of highly specialized manual abilities and, crucially, prove applicable also to the construction of social relations. Indeed, Sennett takes up the pragmatist principle that establishes a continuity between the organic and the social. In this view 'the capacities our bodies have to shape physical things are the same capacities we draw on in social relations' (Sennett, 2010: 290).

In conclusion, in considering work done with the hands, with an embodied mind and in the context of a social relations, we are not dealing with unbridgeable paradigmatic differences. For Sennett, a carpenter, an orchestral director and a scientific laboratory technician are all craftsmen. The single necessary condition on which a comparison can effectively be made is that in exercising our crafts we learn not to artificially separate that unity between the head and hand that defines the craftsmanship of artisan work. Therefore, in Sennett's thinking the advent of technology does not necessarily imply a marginalization of handicraft skills, as historically conceived. Strikingly, in fact, the advent of the most evolved digital technologies is currently making a recovery of such abilities possible.

Skill can be defined as 'a practical ability achieved with exercise' (Sennett, 2010, 44), and the new information technologies render a dynamic feedback enabling the learning from

experience ever more possible. Thus, all the elements present in Plato's hymn to Hephaestus, in particular the aspiration to quality, the control over processes, the participated and shared dimension, and the unity between individual ability and social community become present in the new forms of organization of work used to develop, for example, open source software (e.g. Linux) and, more generally, of all the forms of computer science development defined as 'bazaar' by Eric Raymond (2001). Obviously here, one is referring to a potential that is not yet fulfilled. By indicating the opportunities provided by the new digital technologies – such as the design of Computer Assisted Design (CAD) systems - Sennett emphasizes how they can also induce their 'improper' (repetitive, static, alienated) use, namely, that oriented toward a disconnection of reality from simulation.

4.6 Conclusion

This chapter has reflected on the study question of what kind of socio-anthropological data can help us in understanding if the relationship between corporeal experience and material reality is still relevant in defining the idea of technicity. In a nutshell, if we must really consider the innovative and skilled handicraft experience of the world to be something relegated to a distant past.

I have focussed here on two different theoretical contributions. First, the work of British anthropologist Tim Ingold has been used to highlight the 'ecological' principle following which, while the hand as a single organ may represent the privileged *locus* of technical skills, these are actually more generally nested within 'technicity', namely, in the particular alignment (tuning) between corporeity, the situational context, the material and tools used.

Finally, with the support of theoretical contributions of a pragmatist and phenomenological inclination, I have sought to illustrate how the reduction of the manual dimension of work (in our view its demise is highly improbable) does not necessarily imply a regression of the innovative nature and the singularity of action preserved in human experience. For this reason, the development of mechanical and electronic technology and, more recently, of the digital has not brought about many of the pessimistic prophecies that over the years

have foretold the end of creative handicraft skills tied to the expert use of tools. I have sought to highlight that if it is not a single organ representing the privileged *locus* of the technical skills, these being linked to the tuning of our body with the surrounding environment, then the advent of modern technologies cannot do away with such locus in absolute terms, transferring it to technological design encapsulated in a set of rules and defined algorithms. Indeed, the user is still and will always be a body operating within a context.

As indicated by the work of Sennett, the advent of new (digital) technologies is opening up interesting potential margins of recovering a dynamic feedback between operator, tool and environment (physical and social). Undoubtedly, this feedback is no longer prevalently centred on the manual and corporeal dimension of skill (which nonetheless does not vanish, and can indeed be re-valorized[94]); emphasis nowadays is on the intellectual and socio-relational dimension. The consequence of this argument which will be the theoretical starting point for the next chapter is that today there are (at least potentially) relevant theoretical and practical margins in which to stimulate a recovery of the value of experienced and skillful technical action. This clearly does not mean returning to the manual, but rather recreating the social and institutional conditions that render it possible.

The appeal of Anthony Giddens (1991) to develop social practices of reappropriating technology (re-skilling practices) should, I would submit, precisely be interpreted in this light. This involves practices aimed at empowering individuals and communities due to the participatory and shared rehabilitation of technological production (*ex-ante*) and not only of its use (*ex-post*). It is to these experiences and practices of re-appropriation (Feenberg, 1999) technology that the most interesting future developments of an innovative technological action are tied. Increasingly, the new digital technologies and the application of open source cooperative models make these experiences a less utopian goal.

Thus, it can be argued that the advent of modern technology is not, in fact, a process fatally deteriorating the relationship between body experience and material reality. This relation is changed, but has not disappeared. Moreover, it is suggested, the innovative and skilled

[94] One might consider the recovery of gestural and corporeal skills that digital technologies have made possible in the framework of the new generation of videogames complete with motion controller (Meneghelli, 2011).

handicraft experience of the world is not as something relegated to a distant past because: we still have room for manoeuver to recover the apparently eroded skilled abilities in technical action, which will be elaborated further in the next chapter.

Chapter 5

The recovery of experience and social skills in modern technology development[95]

5.1 Introduction

Having i) discussed the bio-anthropological paradigm of epigenetics as explaining and justifying the importance of experience in human life and culture (Chapter 2), and ii) shifted to a socio-anthropological field of analysis with an ecological and pragmatist view defining 'technicity' as an interweaving between organism (the body), tools and environment (Chapter 3), the final move in this theoretical exploration aiming to understand if there is a place or at least room for manoeuver for the introduction of human and social experience and action in technological development involves an investigation into some empirical cases that appear to demonstrate this it is to this end, therefore, that the present chapter addresses the (third) study question, regarding practices of technological development that are in a position to concretely recover human skills within technical innovation processes, and, moreover, give voice to advocates for a greater democratization of technology.

Attempting to answer (the first part of) this question on recovering skills will help to begin the process of sketching a modern version of the philosophy of praxis applied to new technologies. This chapter will concentrate more on a socio-political analysis, because the rediscovery of skills and experience within technological innovation processes inevitably oblige us to reflect on the issue of participation – which in turn raises issues around the possibilities for a democratization of technology (the second part of the question). The focus is placed on a particular technological practice, that of open source, since this is

[95] This chapter is based on the content of the published article: G. Nicolosi and G. Ruivenkamp (2013), Re-skilling the Social Practices: Open Source and Life. Towards a 'Commons-based Peer Production' in Agro-biotechnology?, *Science and Engineering Ethics*, 19(3), 1181-1200.

understood as paving the way to a new participatory development model of technology, one that is more open to human action, more democratic. This model, it is argued, has the capacity to establish a participatory approach that makes the hegemonic 'technical code' discussed by Andrew Feenberg an open entity wherein it is possible to realize creative appropriation processes designed to literally (re-)invent new and used technologies. In this chapter, I will try to apply such principles to the emblematic and controversial case of biotechnology development.

In particular, there appears to be room for maneuver in order to conceive of and also concretely produce *reskilling practices* (Giddens, 1991). It seems possible, we believe it is possible to develop practices aimed at the re-encapsulation of technology within social relations; practices aimed at an *empowerment* of communities and the participatory and shared rehabilitation of technological production *ex-ante* with the aim of supporting a more democratic endogenous development (Van der Ploeg & Long, 1994) with the potential to bind technological innovation (more closely) to the goals of social sustainability.

The idea affirmed here is that it is possible to propose substantial criticisms to the belief of the radical uprooting of technology and in such a way as to offer a positive alternative to the pessimistic apocalyptic visions of technology (Chapter three). Actually, many authors (Oyama, 1998; Ingold 1997; Latour, 1991; etc.) have expounded on the deeply rooted prejudice in modern Western societies that considers technology and society two separate and independent entities and from which is constructed a scientific and cultural paradigm (Kuhn, 1962) tending to interpret technology as a neutral entity, detached from the social context within which it has developed. This prejudice thus is named here 'the detachment paradigm' just to emphasize that it is based on an epistemological bias founded on the radical separation of human experience and skills from technology development. As we discussed in chapter one and third, according to this paradigm, the interweaving of human experience and technique is a special (unique) condition which can be considered as relegated to a classic golden age by now definitively passed away. Indeed, this interlacing appeared to many authors as irreparably lost. Particularly, modern societies, by activating processes of radical mechanization, were to have dramatically broken the nexus between

action and perception.[96] Besides, the processes of *uprooting* and *abstraction* of work and technical action imposed by mechanical automation and linked to the externalization of the forces of production had already been widely described in classic socio-anthropological literature (Durkheim, Marx, Weber, etc.).[97]

The epistemological position taken here is that these uprooting processes, although real and often dramatic, have been overemphasized. This has resulted in their obscuring of an anthropological given – the corporality of man and thus the embodiedness of technique - that remains ineliminable, summarized by François Sigaut as 'the law of the irreducibility of skills'. That is, the process of *deskillization* can never be brought to completion because the fundamental relationship between the body and instrument means that 'new skills tend to continually develop around new machines' (Sigaut, 1994: 446).[98] Indeed, Sigaut (2007) writes of technique as the foundation of human sociability, with a relationship between the real, ego and the other – a 'triangle of sense' - created precisely with technical and suitably-equipped (*outillée*) action. At the root of this action is the *sharing of experience*, which renders technique the source of pleasure and social in its essence.

Tim Ingold, as described (Chapter 3) has demonstrated how technical action originates in *skill;* technique is a *skilled practice* in which both the natural and social technical domains are not distinct because technique, corporeity, environment and sociality are different facets of the same thing. As an expert practice founded on attention and perception,

[96] Indeed, very often our action is not linked to the direct perception of the material reality upon which we act, Since action is technologically mediated.

[97] Critical sociological literature from Karl Marx and subsequently both orthodox Marxist thought (e.g. Braverman, 1974), and that of a post-Marxist line (e.g. Gorz, 1988) has focused widely on the tendency of industrial capitalism to produce the de-skillization (Friedmann, 1946) of the workforce (characterize by some as *proletarization*). Anthony Giddens (1990) has re-articulated the Marxist theme, presenting modernity in itself as a long process of uprooting social relations from local contexts of space-time interaction, with the main mechanisms of uprooting (disembedding) enabled through the symbolic tokens of, for instance money and expert systems 'systems of technical accomplishment or professional expertise that organize large areas of the material and social environments in which we live today' (Giddens, 1990:27).

[98] The theory of alienation (Marx, 1959 [1844]) has probably had a decisive impact in obscuring this in critical theory. In reality, however, as Ingold observes, assembly line labourers still need to develop task-oriented skills. It is precisely due to this 'coping with machines' that workers effectively resist the attempt to reduce their activity to the mere execution of a command generated by the forces of production and thence produce, beyond goods for the capitalist, social and personal identity: 'it is true that the machinery that workers are required to operate may - on account of its noise, heat, vibration or whatever - strain the human body to its limits of tolerance. However, despite Marx's claim to the contrary, the worker does not cease to dwell in the workplace. He is "at home" there. But home is often a profoundly uncomfortable place to be' (Ingold, 2000b: 332).

imitation and improvisation, skill weaves together the dimensions of human action and fuses them in an inextricable interlacing.

It is in the context of this analysis of skill and de-skilling that the present chapter sets out to discuss *open source* as an emblematic example of *re-skilling practices,* in order to illustrate how more room for maneuver for the *social embedment* of technologies is emerging. The following section looks at the general concept of open source, defining it as a special form of commons-based peer production. The third section considers the opportunity we have today to use open source as a method for the re-invention of technologies, by changing their the codes from within, employing the domain of agro-biotechnology as a case study, and suggest new perspectives for a rational democratization of technology development (the final concluding section).

This all serves to address the third study question regarding practices of technological development that are in a position to concretely recover human skills in the processes of technical innovation and thereby promote a greater democratization of technology. Thus the main research question – that of how the primary relationship between body, society and technique and its transformation by the advent of modern technology – is approached from a socio-political perspective. In this, it is taken as assumed that the presumed neutrality of technological development, in reality, constitutes an ideological veil that tends to support and satisfy consolidated political and economic interests (Noble, 1993), and that to view technological development separately from the social context, moreover, implies the substantial renunciation of support for efforts aimed at conceiving of a socially oriented technology (Gallino, 2007).[99]

[99] Indeed, many science and technology studies (e.g. Bijker, 1995) have been emphasised that technology should be considered the product of a techno-scientific and social *co-creation* process.

5.2 Open source as commons-based peer production

5.2.1 Open source

Open source as a concept and practice is founded on the principle of free access to knowledge and information. Historically, it emerged within the framework of information technology. Indeed, open source is the fruit of the evolution of a debate and a social practice that, beginning from the 1960s and 70s, accompanied the development of free software[100] and *copyleft*[101] in the context of a hacker ethic (Himanen, 2001). The innovative aspect of open source derives from the ability to purposefully incorporate socio-cultural, political, economic and organizational dimensions within a technological product, specifically in the interest of democratization.

From the socio-cultural point of view, open source re-introduces a dynamics of exchange founded on an obligation based on three actions: giving, receiving and giving back. From this viewpoint, open source reproduces a very similar model to what Marcel Mauss (1923-1924) described when referring to the forms of social bonding typical of pre-trade societies (Berra & Meo, 2001) and that was later taken up by Karl Polanyi (1944) to formulate his theory of the embeddedness of the economy in society criticizing the (neo)classical economic argument of the naturalness of the market and the underlying anthropology of *homo oeconomicus*.

From the political point of view, the hacker ethic proposes a libertarian and socialist vision of society. Here, open source can be understood, at least in principle, as a movement of

[100] Software programming based on the freedom to execute, study, copy, distribute and improve is formulated in complete contrast to proprietary software (most famously Microsoft) that uses the system of patents to hinder the free circulation of information (Stallman, 2002). Obviously, this refers to the digital information encapsulated in the source code of software, the so-called 'kernel'. The first experiences of information technology in the 60s were characterized precisely by these freedoms. For a history of free software see also Paccagnella, 2004.

[101] This play on words referring to an inversion of the concept of copyright and echoes the idea of an 'author's permission' in formalizing the protection of free software through means of a license. In brief, copyleft involves a legal document- the Gnu/Gpl (Gnu/General Public License) - in which those using and modifying the free software are committed, in a reciprocal spirit, to apply and grant the same freedoms to other potential users. Not to be confused with freeware and shareware that do not guarantee any of the freedoms of free software, the Gnu/Gpl license has been created with the specific aim of avoiding the free-riding phenomena typically associated with public assets in which accessible goods are modified and rendered inaccessible. The first version (1.0) of this license was elaborated by Stallman and Eben Moglen for the earliest versions of Gnu Emacs.

resistance against de-skillization (or proletarization) and of the creation of alternative strategies of innovation and production that are aimed at re-skillization (de-proletarization). The open source movement strives for a non-proprietary, commons based innovation model which guarantees the possibility of users designing their own software and thus becoming producers, no longer just users or consumers of software. It thereby enables them to create – as a community – their own sociotechnical environment. Re-skillization in fact means user empowerment, the ability to participate in the process of technological innovations and a move away from passive consumption. A core aspect of this alternative innovation trajectory is that open source transcends the dualism of user-designer and producer-consumer.

From an economic standpoint, open source represents a radical criticism of capitalism and its foundation on patents and champions for profits through a circulation of knowledge that may be characterized as *coopetition* (cooperation and competition). This twin aspect reflects the two main currents of open source which emerged in the 1990s. One current considers free software to be not only a simple methodology of information technology development, but a genuine ideology aimed at subverting the model of capitalist society in a libertarian vein. Here, the open source model is seen as a non-proprietary mode of innovation in which experience and skills are revitalized on a communitarian basis. The other current makes the principles of open source and sharing subservient to the goal of profit making and envisages a system of licenses that allows a greater promiscuity between free and proprietary software. It does not refute the market economy, and indeed aims at using open source for potential competitive advantage (Paccagnella, 2010). This twin aspect has been represented also by different associations (the Free Software Foundation with Stallman and Open Source Initiative with Eric Raymond). Today it is preferential to speak of FLOSS (Free/Libre Open Source Software).

Finally, from the organizational point of view, the contrast between typical models of proprietary software and those of free software has been widely represented in the metaphors of the ‘cathedral’ and the ‘bazaar’ (Raymond, 2001). The cathedral model supports planning driven by the various phases of segmented work with a consequent loss by the mere executors of any form of ‘local intelligence’. The bazaar model, on the other hand, self-organized, rooted, acephalous and flexible, is founded on the force of the

cooperative motivation of participants, emphasizing what might be understood in terms of Mauss' anthropology of the gift.[102] This constitutes a logic that can strengthen the social bond, anchoring it to an alternative model of exchange to those of the market economy and state centralism.

5.2.2 Open source, open knowledge, commons-based peer production

Free software theory (and practice) anchors its discourse within the analysis of *knowledge as commons*. Since this analysis has its roots in the field of interdisciplinary studies of shared natural resources (water, forests, fisheries, etc.), there are some differences and similarities between this the new knowledge commons. [103] The main difference between the traditional understanding of environmentalcommons and the recent conceptual development of knowledge commonsis that natural resources are usually subtractive, meaning that their consumption by one person prejudices the possibility of consumption by another, while knowledge is relatively non-subtractive, since the more people who share knowledge, the greater the common good.[104]

Another difference can be put. Some authors (e.g. Braman, 1989) prefer to refer to a 'dual functionality' of knowledge (for human needs and economic goods) just to highlight its complexity and controversiality. Indeed, as immaterial entity (ideas, thoughts, etc.) it can be considered as a 'public good'[105], but as an economic good (books, CD, newspapers, etc.) it is easily converted to a capitalistic commodity with serious access and preservation

[102] The concept of gift elaborated by Mauss, it should be noted, does not have any connection with the modern concept of donation, but goes back, on the contrary, to a form of social bond founded on the obligation of reciprocity.

[103] Traditionally understood as elements of the environment shared by all, 'commons' came to refer to a wide range of non-private goods.Technically defined by Elinor Ostrom as a 'common-pool resources' (CPR), these are a type of good consisting of a natural or human-made resource system (e.g. an irrigation system or fishing grounds), whose size or characteristics makes it costly (though not impossible), to exclude potential beneficiaries from using it. Unlike pure public goods, common pool resources face problems of congestion or overuse. A common-pool resource typically consists of a core resource (e.g. water or fish), which defines the *stock variable*, while providing a limited quantity of extractable fringe units, which defines the *flow variable*. While the core resource is to be protected or entertained in order to allow for its continuous exploitation, the fringe units can be harvested or consumed.

[104] For this reason, Hess and Ostrom (2007: 5) suggest that 'the unifying thread in all commons resources is that they are jointly used, managed by groups of varying sizes and interests. Self-organized commons require strong collective-action and self-governing mechanisms, as well as a high degree of social capital on the part of the stakeholders'.

[105] In economics, a good is defined as public when for a series of natural and/or cultural circumstances (which can also change in time) it is characterized by a low degree of 'rivalry'(competition for a scarcity) and for a low degree of excludability (difficulty in preventing its use). For the notion of 'public good' and its specificity within the theory of commons, see Ostrom (1990).

issues. New media and digital technologies have brought both faces of this Janus to the fore, entailing an ambivalent complexity.

In all fields in which information, knowledge and goods which are *information-dense* play a fundamental role, and these are expanding quite rapidly in today's network society (Castells, 1996), it is possible to realize practices of open access[106] that render such assets ever more usable, including (and especially) by those who have been traditionally excluded[107]. This can enable the emergence of (individual and collective) practical skills, based on a non-proprietary logic and grounded in cooperative actions, skills that escape the regulation both of the state and the market. Yochai Benkler has characterized these actions as 'commons-based peer production':

> Commons-based peer production is a socio-economic system of production that is emerging in the digitally networked environment. Facilitated by the technical infrastructure of the Internet, the hallmark of this socio-technical system is collaboration between large groups of individuals, sometimes in the order of tens or even hundreds of thousands, who cooperate effectively to provide information, knowledge or cultural goods without relying on either market pricing or managerial hierarchies to coordinate their common enterprise. (Benkler, 2006a: 395)

Benkler goes on to single out the main characteristic of these forms of production precisely in the fact that nobody has exclusive control over the use of resources. On the contrary, they are based on what is essentially a freedom of access regulated only by a general symmetry of reciprocity. The principle guideline is that of sharing (and developing) knowledge and information and with production substantially decentralized, no institutionalized hierarchy of system is envisaged.

For these forms of production, the Internet represents the main material and symbolic infrastructure of action and sharing. The underlying assumption lies in the conviction that also more complex tasks, has been assumed to require a high levels of specialization attributed to professionals with advanced skills, can be reorganized (by moderators accredited with systems of appraisal between peers) and, therefore, realized by simply

[106]This issue of the highly important potential of access require in-depth theoretical and practical reflection on the commons in the next few years (Hess & Ostrom, 2007).

[107]The French philosopher Michel Serres, in an interview in France-Info, has recently spoken on the revolutionary potential of this aspect in highly significant terms. See http://www.fabriquedesens.net/A-propos-de-Wikipedia-Michel-Serre

interested volunteers and with intrinsic motivations bound to social rewards. In the last instance, these forms of production mostly play on a non-economic capital, namely social capital.

It is important to note that commons transcend the traditional division between the private and the public; commons do not refer to the traditional notions of community or the public. Commons are based on the free and open communication and collaboration and arise from social processes of production resting on voluntary cooperation and enabled by digital network technologies. It is a productive cooperation that produces and sustains commons. Instituting commons requires a shift from a focus on the public interest – the *res publica* – to that of the interest in commons – *the res communis*. This commons-based knowledge production enables and requires a new research network configuration built upon open codes, re-skilling practices and democracy.

5.3 Democracy, open codes and reskilling practices: the case of life technologies

Benkler rightly asserts that a wider accessibility to knowledge and information may surely have a remarkable impact on reducing the serious imbalances that undermine the basis of world-wide human development. Indeed, this is closely correlated to the real development of some specific fields like food, health, education. In all of these fields, a determining role is being played today by information-embedded products, goods and tools (Benkler, 2006b). The application here of commons-based forms of production of these information-based products may contribute to a fairer human development by facilitating bottom-up decentralized practices. In this sense, open source may help us avoid what was efficaciously defined 'the tragedy of the anti-commons' (Heller, 1998) - an expression coined in criticism of the unscrupulous use that many liberal economists continue to make of the famous dilemma formulated by the American ecologist Garrett James Hardin (1968) as 'the tragedy of the commons' in which a plurality of individuals use a common good and, acting rationally to pursue their own short-lived private interests, end up by squandering the (limited) common resources, which evidently harms their own interests over the long term (hence the 'tragedy').

The tragedy of the anti-commons describes an opposite situation, in which the proliferation of holders of property rights frustrate the possibility of reaching a desirable social result, owing to the collapse of the mechanisms of coordination needed to ensure the development and marketing of the products. Indeed, economists recognize that if the ownership rights of multiple components of a single technology are held by a relatively high number of entities (individuals or companies), the marketing and development of products requires considerable effort of coordination between the various parties involved. In an ideal world without transaction costs,[108] this would not create particular negotiation problems. Reality is very different, however, and transaction costs are often so high as to hinder negotiation with the paradoxical effect of preventing the satisfaction of both private interests and those of the public.

This theory has not been spared by criticism. Particularly strong is that elaborated by the neo-liberal jurist Richard A. Epstein. Referring to biomedical research, Epstein claims that Heller overestimated the problems of patent protection at both theoretical and empirical levels. Empirically, the number of patents filed has continued to grow. Theoretically, according to Epstein (2004), Heller fails because of a set of 'faulty analogies' – primarily between patent system and natural barriers as well as bureaucratic permits.

Concerning the first of these, Epstein argues that nature can erect a barrier against innovation[109], but this is not the case in the world of biomedical research. Concerning the second analogy, Epstein argues that the parallel is not pertinent because the patent is always a 'wasting asset'. Actually, the legal monopoly created by a patent is limited in time and, even during the period of its validity, new and old patents or new technologies can challenge its dominance. Epstein claims that 'those who do not deal will not prosper, so that the entire culture works in ways that encourage various forms of cooperation'. Essentially, therefore, Epstein believes that patents do not necessarily create economic blockades and that the fear for anti-commons is based on a faulty imagination. People imagine that each patent operates alone. At the contrary, he says 'in most instances, an aggressive program of patent pooling changes the overall landscape'.

[108] One in which all the players have a perfect knowledge of all the variables at play and in which there are no associated impediments or costs to negotiation.
[109] He cites as an example the blocking power of multiple owners controlling different segments of a river.

Epstein's authoritative opinion has also been contested, in turn, as being founded on weak theoretical and empirical underlying assumptions. It is important to note that part of this criticism comes from outside the open source movement (see Dreyfuss, 2003). Clearly the framework of patenting and open access is controversial and complex. For example, since the rapid expansion of the intangible or immaterial commons in particular communications systems and genetic information commons, private companies in all areas of production have attempted to privatize parts of these commons for the purpose of commercialization and commoditization. As detailed below (4.3.1), these so-called 'new enclosures of the commons' – latter day versions of the earlier enclosures of the natural commons during the initial stages of capitalism, now concerning the immaterial commons – do seem have led to a widespread 'tragedy of the anti-commons'. It is partly as a result of this that the new enclosures have also met with increasing resistance globally by alternative legal, technical and politico-economic strategies employed by all kinds of local and global movements fighting for the protection the commons or the reclamation of them, movements like the free software movement, the peer-to-peer movement, creative commons, open access, A2K among many others.

5.3.1 The case of agro-biotechnologies

The 'tragedy of the anti-commons' has been given by biotechnologies, both the 'red' (health and pharmaceutical fields) as well as 'green' (agricultural sector) varieties. The effort that began in the 1930s to increase crop yields and boost the nutritional quality of produced food in order to reduce the impact of famine and malnutrition has prompted proprietary processes of techno-scientific innovation that can no longer respond satisfactorily to human needs, as demonstrated by the case of Golden Rice, a variety of genetically modified rice with the aim of boosting the vitamin A intake of the poor. The vetoes, obstacles and very high costs caused by the combination of tens of patents (distributed throughout the world) weighing on the several passages that obligatorily must be tackled for its realization have given rise to an inextricable legal and economic tangle. This predicament has made Golden Rice a rather ineffective product (Hope, 2008). The problem with Golden Rice thus exemplify well how the resorting to the politics of proprietary patents has transformed a potentially revolutionary product into a tragic paradox.

This disheartening narrative can easily be generalized to all the experiences of a proprietary kind regarding biotechnology. Globally, a picture emerges in which the levels of social equity, the defense of environmental resources and public health have often been subjected to critical distortions. The case of genetically modified organisms (GMOs) is only the most glaring, as observed by critiques from the perspectives of socio-economics (impoverishment and mass proletarization of small-holders farmers in poor countries), the environment (reduction of biodiversity) and real effectiveness (Shiva, 2004) – and this without taking account of the serious symbolic crisis that they have caused also in the rich and economically developed world (Nicolosi, 2007).

By means of a patenting policy based on 'exclusion', the biotechnological industry has increasingly restricted crop farmers' access to phytogenetic resources. Germplasm is the raw material on which any program of plant-breeding is based and to which selectors have traditionally always had free access in order to make on-going selective improvements in plants varieties over the course of several generations. The advent of GMOs has drastically changed this situation. In an apparently paradoxical way, indeed, what has happened is a typical example of antisocial free-riding. The selector (often a multinational corporation) patents (and therefore renders inaccessible) a germplasm that is itself the result of the crossing of genes and other germplasm developed by other selectors in a system of free access, sometimes from the cultural practices of indigenous communities, and sometimes within programs financed with public funds or by international research centers and made freely available to all.

One of the more sensational instances of patenting fundamentalism occurred with the development and patenting of seeds rendered artificially sterile in order to exclude the possibility that they might be re-sown by farmers[110]. By separating seeds (and the genetic information contained within them) from the harvest and, therefore, from the socio-cultural practices and the natural environment that traditionally generated and 'safeguarded' it, conventional biotechnologies have made farmers dependent on the specialist globalized

[110]Genetic use restriction technology (GURT), colloquially known as 'terminator technology' or suicide seeds restricts the use of GM plants by causing second generation seeds to be sterile. Initially developed as a concept by the US Department of Agriculture and multinational seed companies, such seeds have not been commercialized anywhere in the world due to opposition from farmers, indigenous peoples, NGOs, and some governments. In 2000, the United Nations Convention on Biological Diversity recommended a *de facto*moratorium on the field-testing and commercial sale of terminator seeds, which was re-affirmed in 2006. India and Brazil have passed national laws to prohibit the technology.

multinationals and owners of highly expensive patents (Kloppenburg, 2005) which enable these firms to programme the agricultural production at a distance (Ruivenkamp, 2005).

The production of food and the development of agricultural techniques are the fruit of an age-old storehouse of social, cultural and symbolic resources. This storehouse is marginalized by the present processes of scientific production, uprooting food and agriculture from local traditions and causing an unequal distribution of benefits to the clear gain of the big globalized players[111]. In practice, the privatization of biodiversity has effected a gradual erosion of the sovereignty that farmers have had in the past over their relationships with their seeds (Kloppenburg, 2010). What we have witnessed, therefore, has been the systematic expropriation of symbolic and material resources by opaque and uprooted international knowledge networks (Ruivenkamp, 2008).

5.3.2 Democratizing innovation: opening codes

The Golden Rice example may be conceived as symbolizing the new enclosure trajectory in knowledge production that characterizes the last thirty years of techno-scientific development. This trajectory has introduced serious inefficiencies that have drastically limited the economic and social potential of knowledge production. It is assumed that open source can resolve some of these problems, adapting knowledge production to the real needs of users also in the cases where the potential market is not broad, and speeding up innovative processes, making them economically more accessible and more reliable. Moreover, and this is no secondary matter, open source can facilitate a greater democratization of innovation since it guarantees an effective involvement of the user/consumer – or *prosumer* - in the processes of technological innovation (Von Hippel, 2005).

In open source, the one-way and top-down logic of the traditional practices of consumption is radically overturned. There is also, it should be emphasized a broad literature in social sciences and humanities (mainly neo-Marxist) criticizing the actual extent of this process.

[111]According to the International Center for Agriculture Research (ICARDA), today approximately 50% of the world market of seeds is monopolized by four large biotechnological multinationals: Monsanto (USA), DuPont (USA), Syngenta (CH) and Groupe Limagrain (f). A similar statement can be made with reference to pesticide production: Bayer (D), Syngenta (CH), BASF (D), Dow Agrosciences (USA), Monsanto (USA) and DuPont (USA).

Some of these authors (e.g. Suarez-Villa, 2001) consider prosumerism, and more generally the practical involvement of the user, as little more than just a new form of exploitation in the age of techno-capitalism, where the reproduction of knowledge has become the most important function of society since it is replacing the process of reproduction of capital. According to Suarez-Villa, the emergence of the so-called knowledge society has rendered creativity and knowledge the scarcest resources for capital. Under techno-capitalism, knowledge assumes the properties of a private commodity, as much as raw materials or labor power did under industrial capitalism. For this reason, there are pressures to globalize and commodify intellectual property (patenting). This system, he argues, is strongly dominated by big corporations since the vast majority of new technologies, and particularly the most valuable ones, are spawned within corporate structures. The most radical example of this process, says Suarez-Villa, is the commodification of life itself with the acquisition of patents in the field of genetics, with biotechnology companies obtaining patents on decoded genes that can be used to develop new drugs. In this context, each innovation produced outside the corporation framework is, in the end, appropriated and absorbed by it.

This is the case of open source, Suarez-Villa claims, but it is also the case of prosumerism where the user contribution to innovation helps corporations increase profits through the most sophisticated and pervasive example of alienation. Here, neo-Marxism finds significant support in governamentality[112], inspired by the post-structuralist thought of Foucault. From this perspective, individual freedom, empowerment and technology of the self express contradictory trends as they have ambivalent critical points where their implied liberalism may suddenly change to its opposite and incorporated (embodied) forms of control and can become a dramatic 'microphysics of power'. That is, disciplinary techniques of the self can very easily become disciplinary technologies of power; people may believe they are able to express themselves and their autonomy, but really they effectively find the 'right' way to align themselves to the power desiderata. Here, 'the autonomy of the self is thus not the eternal antithesis of political power but one of the objectives and instruments of modern mentalities for the conduct of conduct' (Rose, 1996: 155).

[112] That is, 'the dramatic expansion in the scope of government, featuring an increase in the number and size of the governmental calculation mechanisms' (Hunt and Wickham, 1994: 76).

While appreciating these radical and well-founded interpretations, however in this chapter, a different position is advocated. The skilled involvement of user *can* - I argue – on the basis of a choice supported by political and ethical awareness, move in the direction of the ideal 'democratic rationalization' of technology of which Andrew Feenberg (2010) speaks. There are two reasons for this affirmation.

First of all, open source commons based knowledge production radically develops a potential implicit in every technology, and one that in contrast to the 'essentialist' vision of the philosophy of technology, such as that developed by Heidegger (1.4.3), confirms that technological development is always bound to the socio-historical contingency, as demonstrated by constructivist sociological analysis (Bloor, 1991; Latour, 1987; etc.). It was probably the author Andrew Feenberg who has best expressed this principle from a philosophical perspective, at the same time highlighting all its democratic and emancipatory political potential. Bearing in mind the teachings of the heterodox Marxism of Antonio Gramsci (1975), Feenberg (1999) specifically focuses on the hegemonic content that is encapsulated within technological objects, both at the level of the social meaning of individual objects and the deeper values they assume, inscribed as a technical code and indicating the possibility for resistance of the hegemonic through a re-encoding (1.4.5):

Feenberg thus the establishment of a participatory method that renders the code an open entity in which processes of creative appropriation can be fulfilled, aimed literally at re-inventing technologies.[113] I would argue that open source, commons based knowledge production realizes this proposal today, opening real operating spaces for re-inventing technologies that did not formerly exist.

Secondly, but in a closely correlated way, the processes of participation activated by the open source logic offer another important aspect the issue (also tackled by Feenberg) the need to limit the solipsistic power of technocracy. This is a power that, in modern societies, is often more substantial than the political system itself. Technicians, as is known, exercise an influence and control over communities that goes beyond that exercised by the institutions appointed to implement democracy. Winner (1995) speaks of the influence of

[113] Feenberg's studies have been applied to the medical (AIDS) and information technology world (MINITEL in France).

technocracy in terms of a new form of legislative power lacking representativeness. For such reasons, for example, Richard Sclove, one of the most influential authors in this field, supports the need to find new ways to integrate user participation into the processes of technological design (Sclove, 1995; 2010) and points specifically toward non-specialists to limit the autonomy and self-referentiality of technical staff[114]. In order to achieve this, Sclove refers to the need to revitalize local communities to favor the growth of their independence and ability to govern science and technique.

Open source, commons-based knowledge production heads right in the direction indicated by Sclove through the activation of a re-skilling process that re-directs a part of the design and technical creation process into the hands of non-experts and, therefore, of the communities in which the technology unfolds its effects. In this sense, they become fully inserted in the river bed of re-skilling practices (Giddens, 1991), oriented toward empowering communities based on the re-appropriation of knowledge and know-how (*savoir-faire*) expropriated from techno-scientific 'abstract systems'.

5.3.3 Re-skilling practices

Further developing the discussion of the value and epistemological and ontological importance of skills, Richard Sennett has elaborated the Jeffersonian ideal according to which democratic competence resides in skills practiced to modify material conditions. He points out that citizenship can be lost or earned through the material conditions of labor and proposes forward artisan work as the ideal form in which participation, sharing, personal realization and social bonds are articulated.

With this argument, the American sociologist critically reviews of the thought of one of his masters, Hanna Arendt, whose analysis of the 'human condition' (Arendt, 1964) distinguishes two figures of the human being at work: the *animal laborans* and the *homo faber*. The first echoes a vision of man as a beast of burden, referring to the repetitive and laborious dimension of work. The second, instead, recalls a higher world of the activity of building a communal life. For Arendt, the figure of the *homo faber* goes directly back to

[114]These themes have been keenly and seminally discussed by John Dewey (1927). For this reason, a pragmatist shift has been ascribed to Feenberg (Hickman, 2001) from which Feenberg (2003) has disassociated himself.

the high and noble art of Politics (and therefore of Philosophy). In this distinction there is, however an implicit hierarchy:

> *Homo faber* is the judge of material labour and practice, not *Animal laborans*'s colleague but his superior. Thus, in her view, we human beings live in two dimensions. In one we make things; in this condition we are amoral, absorbed in a task. We also harbour another, higher way of life in which we stop producing and start discussing and judging together. Whereas *Animal laborans* is fixated with the question 'How?' *Homo faber* asks 'Why?' (Sennett, 2008: 6-7)

For Sennett, such a distinction makes a fundamental philosophical error that leads to serious ethical and political consequences. In particular, it devalues material labor. For Sennett, work, intended as artisan work, has a founding value for a broad democratic citizenship and is not left in the hands of the expert elite. Working well, indeed, puts people in the condition to govern themselves and educates them toward citizenship. In artisan work, one must learn to reconcile autonomy and authority, but everyone can become good craftsmen since the required abilities are innate.

A central aspect of Sennett's argument is the principle according to which the advent of technology does not necessarily imply a marginalization of artisan skills. On the contrary, the advent of the most highly evolved digital technologies is making their revival possible, with skill defined as a 'trained practice' (Sennett, 2008: 37), and the new information technologies creating a dynamic feedback that can 'learn' from the experience. As already detailed (Chapter 3), all the elements present in Plato's celebration of Hephaestus - in particular the aspiration to quality, the control over processes, the participatory and shared dimension, the unity between individual skill and social community - are present in the new forms of organization of work employed to develop open source software and, more generally, in all the forms of information technology development characterized by Eric Raymond as in the 'bazaar' category.[115] Indeed, Sennett shows how the new information and communication technologies (ICT) allow a revival of 'craftsmanship', 'maestria' in Italian translation (3.5).

[115]Obviously, this refers to a potential. Indeed, Sennett, considering the opportunities furnished by new digital technologies emphasises how they can also induce an 'incorrect' usage (repetitive, static, alienated), that is oriented to a separation between reality and simulation.

For Sennett, therefore, the dystopian techno-phobia of Arendt, albeit comprehensible given the contextual conditions in which her generation lived, goes directly back to the Greek myth of Pandora's casket[116] in establishing her ideal model based on the control *ex post facto* of technology, in which Politics (the Public, the Discourse) must try to face and resolve the problems that have been created by experts and technocrats[117]. Sennett invokes an opposite model, based on a new 'cultural materialism', in which participation must begin before (*ex ante*), when people produce things through material work.

5.4 Conclusion: a copyleft germplasm for re-skilling practices? Problematic issues and possible future developments

Open source exemplifies the important room for maneuver for technology and human experience to be brought together more closely. In the re-skilling processes launched by open source practices, it becomes clear that technology and society are not two distinct entities, that the mutual interweaving through which they are constructed can be intensified with the development of innovative socially embedded technological devices and procedures, and further that modernity has never – as it cannot – completed the uprooting process which has characterized it. It seems that technical rationality is only partially de-contextualized and disembodied, because there do exist practices of technological development that are able to indicate a recovery of human and social skills within technical innovation processes.

With specific reference to the agro-biotechnical domain, it could be said that open source re-skilling practices can give life to a participatory research model that affords farmers a fundamental role. Of course, this is not entirely novel, since it was the first modern economist, Adam Smith, who described the phenomenon in 1776 when referring to a great part of the machines used in the nascent manufacturing industry. Actually, those machines were originally the inventions of common workmen, who employed in some very simple operation, naturally turned their thoughts towards finding out easier and readier methods of performing it. Similarly, and long before Smith, farmers were solving bio-technical

[116]Pandora, we should recall, in Greek mythology is the Goddess of invention. She was sent to Earth by Zeus as a punishment for Prometheus' transgression (the fire theft).
[117]Arendt, for example, was convinced that there should have been a public debate on the atomic bomb when this was created by scientists and technologists.

problems and sharing their inventions with their peers. In this sense, open source agriculture may be regarded more as a restoration than a revolution.

In light of these considerations, although it is not universally acknowledged and there are various critiques drawn from the right (neo-liberals) and the left (neo-Marxists) of the political spectrum, it does appear that open source might be able to promote, in specific circumstances, re-skilling practices oriented towards introducing greater participation and social sharing in the processes of technological production. In the agro-biotechnological field, for example, there are already important experiences of re-skilling practices having the ambitious objective of uniting advanced genetic research and farmers' know-how. We may note here the research and projects of intervention carried out by the research group heading up the Critical Construction Technology (CTC) of the Wageningen University and Research (WUR) and aimed at developing Tailor-Made Biotechnologies (Ruivenkamp, 2005; 2008; 2009; Ruivenkamp at *al.*, 2008); similarly, Participatory Plant Breeding (PPB) developed in Italy and realized throughout the world by Ceccarelli and Grando (Ceccarelli et *al.*, 2007; Ceccarelli, 2009). In both cases, there is an attempt of bottom up technological development that re-encapsulates biotechnologies in the social, cultural and environmental traditions of communities, through the participated collaboration of technologists, scientists, farmers and citizens in a virtuous mechanism of participation and sharing that recovers all the local know-how and environmental resources.

Conventional biotechnologies tend to proceed with the selection of varieties that do not respond to the needs of the poorest farmers working in marginal environments with difficult climatic and social conditions where the paucity of common assets, such as water and the unavailability of seeds, are more often than not critical[118]. Against this, the decentralization of the genetic improvement envisages the use and valorization of the local knowledge of farmers from the beginning of the process, in identifying problems/challenges and goals at which point, crucially in the procedures of biogenetic engineering (technology), the possibilities of genetic variability are still large (i.e., before the options available are narrowed). This process brings farmers and researchers together so that one learns from the other. The participation of farmers in their own agronomic and

[118] The objective of the large biotech corporations is that of creating products able to 'function' in artificially standardized environments by means of the massive use of technologies and chemicals (with prohibitive costs for many farmers). Biodiversity, in this context, is neither contemplated nor valorised.

climatic conditions for the purpose of selection is not only effective, but considerably speeds up the process of adopting new varieties without involving the complex mechanisms of the official release of varieties and production and divulgation of certified seed (c.f. the concomitant risk of anti-commons tragedy) and, moreover, ensures a higher preservation of biodiversity (Ruivenkamp, 2005; 2008; 2009; Ceccarelli et al., 2007; Ceccarelli, 2009).

These methodologies have important implications for democracy. In fact, they show the possibility of opening technical codes and proposing a participatory method oriented to a creative appropriation aimed at re-inventing technologies. From this perspective, the Andrew Feenberg's approach of developing resistance tactics aimed at re-encoding the hegemonic social order incorporated in the technological objects can be realized. This is not an utopian dream any more.

Of course, we are only at the very beginning of this journey. In order to develop and strengthen tailoring and participatory processes in the agro-biotechnological sector, it will be crucial in the next few years to experiment and carry out in-depth research to develop models for the incorporation of open source licenses of intellectual and personal property in biotechnological innovations. Indeed, open source may promote the emergence or strengthening of commons-based production strategies, stimulating a cooperation model that, taking advantage of the potential offered by new technologies, connects the local with the global. Today, there are already important institutes, foundations and programmes thus engaged and applying such local/global model - *glocal* (Bauman, 2005) – model. Organizations aiming to reduce the superpower of the biotechnological patents system include the PIPRA (Public Intellectual Property for Agriculture), a grouping of public American Universities; CGIAR (the Consultative Group on International Agricultural Research)[119]; and, above all, BiOS (Biological Innovation for an Open Society), probably the most ambitious commons-based project oriented toward biotechnological innovation[120].

[119] CGIAR aims to create a web interface sharing data and computer resources in order to access databases distributed throughout the world that contain the traces of the samples of germplasm produced by local agricultural know-how. Access to these data and tools can prove fundamental in the development of useful innovations.

[120] BIOS is an initiative of CAMBIA (Center for the Application of Molecular Biology to International Agriculture), an Australian research institute founded by Richard Jefferson, himself a pioneer in the field of biotechnological research. The BIOS initiative is based on a strong IT component and the application of the

There are, of course, technical and legal difficulties in applying the copyleft or creative commons model (Lessig, 2005) to forms of life and synthetic biology and deriving from such major success in the information technology sector[121]. Partly, this is due to the fact that open source in biotechnology is a young field at a very early stage of development, but there are also some important differences between ICT and biotechnology, which should be briefly discussed.

Firstly, ICT is a field mainly characterized by the copyright law whereas biotechnology is regulated by a patent law system. This difference significantly affects the development opportunities for open source in biotechnology because several aspects of patent law present create challenges to the application of an open source model. Also, and partly related to this, there are crucial differences in respect of the commercialization paths. In the life sciences, a huge amount of money is necessary to 'move' inventions through development, field testing, manufacturing, and distribution, whereas the open source software has no expensive regulatory encumbrances and can be duplicated and distributed with (practically) no marginal costs.

A complication arises here, as Boettiger and Wright (2006) claim, when a product has both commercial and humanitarian markets this point can create some economic and ethical paradoxes. In the case of an AIDS vaccine, for example, the patent owner, usually a public-private partnership, can play with (differentially apply) patent rights in the licensing agreements in order to segment the market and thus provide a specific drug to underserved populations (the patent owner can bargain the licensing of the patent rights with the company engagement in delivering a low cost product into developing countries). In these cases, open source licenses may actually be an encumbrance rather than a solution as they could discourage private investments.[122]

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tools used on a very similar license model to that of copyleft. An historic example of how CAMBIA acts is given by the TransBacter system, in which alternative bacteria to *Agrobacterium tumefaciens* (generally used to transfer DNA into the genome of the plants) are produced. CAMBIA freely supplies these - *Sinorhizobium meliloti*, *Mesorhizobium loti* and *Rhizobium* sp. NGR234 - to both non-profit and for-profit research, but on the condition that eventual genetic improvements are in turn made freely accessible (Broothaearts et al., 2005).

[121]For an overview of these legal difficulties, see Rai and Boyle, 2007.

[122] This may be why BiOS decided to focus on enabling technologies, just to preserve patent rights on application-level technologies.

Another problematic issue that of 'interoperability'. The success of Linux has mainly been linked to its operation as a complete, functional alternative to proprietary operating systems. Linus Torvalds was able to create a kernel through which a set of open source licenses were enabled to become 'viral' tools 'infecting' also proprietary software. This special quality broadened the field of applications integrating open source code. In a sense, the problem is that it is still hard to consider, as many claim, Transbacter as the new kernel of a bio-Linux.

Also economic issues can create what might be referred to as 'cultural' encumbrances to the dissemination of open source in the biotechnological field. A large part of the success of open source in ICTs has been due to the (sub)culture of hackers. In life sciences, open source is supported mainly by researchers operating in the public sector. Here, scientists are rarely, if ever, free to choose how to arrange patents issues because patent rights, differently from copyright on texts, are in the hands of their employer institutions (universities, research organisms, etc.).

Finally, another important cultural issue could become an insurmountable obstacle. In recent years, particularly in Europe, a widespread opposition to GMOs has mushroomed in civil society. Irrational, ideological as well as some well founded bio-safety reasons support this lack of public acceptance. The 'orthorexic society' (Nicolosi, 2007) should not be considered a secondary problem.[123]

There are, presently, various interesting attempts to introduce open source into biotechnology. One particularly significant example is by Tom Michaels' (1999) 'General Public License for Plant Germplasm' (GPLPG). Usable by any person, group or institution, such as individual cultivators, communities, indigenous peoples, scientists, universities, NGOs and private firms, this licensing model, Michaels emphasizes, proposes an adaptation of the GPL software licensing model by means of a 'materials transfer agreement' (MTA). As recently claimed by Jack Kloppenburg (2010), it has a high

[123] *Orthorexia nervosa* is a psycho-cultural syndrome, whose definition is the work of Steve Bratman (2001), that may summarily be described as the obsession for healthy (opportune) feeding. Although the clinical picture has still not been definitively established, it represents a condition that affects an increasing proportion of the western population and, here, serves as a metaphoric representation of an 'epoch-making' condition. The orthorexic passes an important part of his time in search of dietetic perfection, organizing, researching and selecting food.

potential, both from the ‘resistance’ as well as creative points of view. Indeed, the MTA approach has the advantage of developing a legal frame for the recognition of the collective sovereignty of farmers, and to allow these to exchange, improve, conserve and sell seeds.

Notwithstanding this promising developments, however, we are far from being able to say that open source in biology has become a reality. Rather, we should consider it as a ‘work in progress’, experimental and still controversial. Probably, it is still early to say today if we have the appropriate architecture yet. The experience of BiOs and its practical implementation will be very important to understand where we will be able to go in the future. In determining this direction, or these directions, there is still much work and much research to be done. The hope is that, in the next few years, sociologists, philosophers and scientists, together, will prove able to successfully rise to this challenge.

Chapter 6

Discussing skilled experience in technical action: a multidimensional analysis

6.1 Introduction

The theoretical discussion developed thus far have provided, I hope, a contribution to a new theoretical perspective through which to re-consider the reintegration of human experience in technical action. This chapter discusses and criticizes the common assumption of modernity according to which technology is uprooted, de-humanized and de-socialized. Such a discussion may open some interesting perspectives for future research.

Following a rhizomatic method (Chapter 1), I have discussed the research questions developing a semantic map adopting a critical-pragmatic perspective and sensibility. This choice substantially comprises three moves, which involves taking three related positions.

The first move is to refute the *essentialist determinism* that characterizes a significant part of the philosophy and sociology of technique. This has been performed by valorizing the Marxian-Gramscian concept of *praxis*, in which all activities that are objectified in social relationships (institutions, needs, art, science and technology) are the fruit of human praxis and are therefore the consequence of real and material processes grounded in action and social experience. This move away from essentialism and determinism and towards a materialist, Marxian-Gramscian position effectively refutes every kind of abstract determinism. Likewise, any vision of technology that is guided by absolute and incontrovertible principles or by a basic ontological materiality (expressed as embodiment) is similarly rejected. Thus, there is neither unalterable DNA nor an absolute metaphysics that imposes an essence on technological development. Everything is in the hands of man and, therefore, is always modifiable. There is no future history of technology already written. There are instead realities that can be changed by people and social praxes that we are able to implement.

It follows fairly straight-forwardly from a Marxian vein that it is necessary to refuse the contemplative philosophical approach and instead seek to change the world with philosophy; in other words, the dictum is to embody thinking in the concrete actions that may change the world. The emphasis on experience and skills in this thesis is precisely the consequence of this perspective. For the same reason, the emphasis is on the role of social practices rather than abstract principles, and on the arguments of authors who, perhaps with different outlooks on reality, are indebted to the philosophical school of pragmatism (some, like Ingold, Sigaut and Sennett, explicitly, others such as Mauss or Bourdieu, more implicitly, e.g. through their theoretical frame of reference).

The second move is to *reassess the process of production of material things.* This is realized here, in Sennett's terminology, by considering the *homo laborans* rather than the *homo faber,* on the principle that the processes and dynamics leading to the production of material culture, and hence also of technology, reveal the condition of man (people and their social relations) to a greater degree than the presumed absolute qualities of objects. The observation of the dynamic production of material culture unveils the social codes inscribed in objects, reveals their limitations and potential, and shows unequivocally that the neutrality of technology is a chimera. The fact that technology is not neutral means that there are hegemonic codes (Feenberg) characterizing it. These codes are not metaphysical but social and as such always open to transformations - difficult, complex social transformations, which also necessitate conflict, but that are in theory possible.

The third move is to *take a political stance*, assuming that, contrary to a fairly well-consolidated ethico-methodological line in the STS field, the observation of social dynamics and practices that produce, reproduce or co-produce technological objects cannot ultimately be neutral. The social scientist can – and in fact should - call into question a certain social process of technological production in a critical way. Intervening politically in the processes does not means deferring the 'resolution of problems' to a later date, when these processes have become irreversible or hard to modify due to their stratification. Rather, and above all, it means working towards making the involvement and participation of 'non- specialists', enabling those producing or reproducing 'things' to be aware of the social implications that the production *ex-ante* or the usage *ex-post* involve. From this perspective, empowerment is seen as participation and therefore democratization from the bottom-up, beginning with the

processes of production of material culture. Re-skilling practices move precisely in this direction.

This concluding chapter presents the semantic map emerging from this work and develops a general discussion aimed at sketching out some new questions that represent possible proposals for future lines of research.

6.2 Multiple dimensions of experience and skills: a semantic map

The research presented in this thesis has been developed within a general conceptual framework tied to the scientific and political-social debate on the relationship between technology and society. It began from an awareness that an important part of this debate is characterized by a tendency to consider these two as clearly separate. This seemed unsatisfactory and prompted the search for a different perspective. The alternative presented argues not only that technology and society as closely interwoven entity, but also (and primarily) that human experience and skills remain crucial elements of technical action. There are ineliminable socio-anthropological conditions (however reduced they may be) that tend constantly to re-embed and re-contextualize technical action – technique - in the field of human and social experience. This position must reckon with various theories that refute the role that man and experience are here adjudged to play in technical action.

For these reasons, the semantic map presented in this research has been developed starting from the problematic issue defined by the theoretical background (Chapter 2) in which it was assumed that technology and society two independent entities (Figure 1).

Figure 1. Representation of conventional semantic map

In contrast to that assumption, this thesis presents and discusses a theoretical perspective according to which showing there is an intertwining link created by human experience (Figure 2).

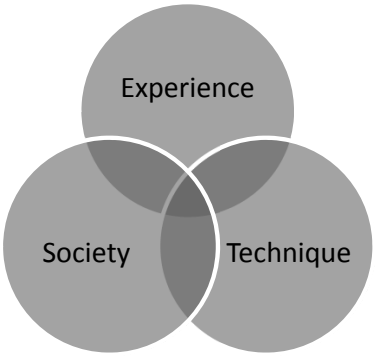

Figure 2. Representation of semantic map presented (interaction)

In this perspective, it is assumed that no technical action exists without experience (Figure 3).

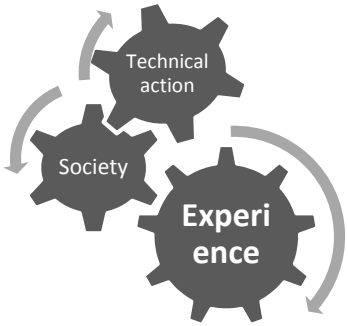

Figure 3. Representation of semantic map presented (dynamics)

More concretely I discussed three theoretical 'access points' supporting this assumption (Chapters 3-5), leading to a multidimensional definition of skilled experience in human technical action that provides a problematized and multifaceted answer to the three study questions. This, in turn, points the way to new research questions indicating possible directions for future research development (below). The three dimensions of the notion of skilled experience in technical action are distinguished and discussed thus:

- Skilled experience in terms of biological character;
- Skilled experience in terms of socio-anthropological givens;
- Skilled experience in terms of socio-political opportunities.

The semantic map emerging from this multidimensional analysis may be presented as shown (Figure 4):

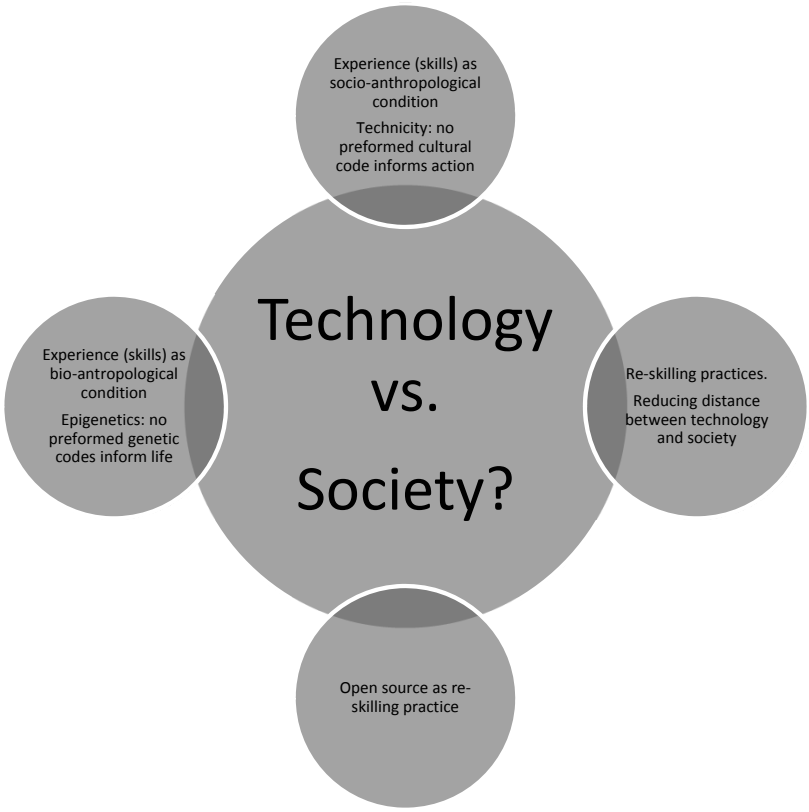

Figure 4. Representation of semantic map presented (multidimensional analysis)

6.2.1 Skilled experience in terms of (ineliminable) biological character

Chapter 3 addressed the question of whether there is a bio-anthropological character able to explain and justify the relevance of experience in human culture and an epistemological paradigm that may represent such a basis in life sciences. To answer the question, I set out to show that experience and skills are an ineliminable anthropological given since they are bound to the very biological nature of man, a condition anchored in our interrelation and reciprocity with the environment. For this reason, an epistemological paradigm is described that, taking a biological viewpoint, has its main foundation in an epigenetic perspective.

Clearly, the epigenetic approach does not deny that every organism begins its life endowed with a genome. Rather, it asserts that there is no model of interpreting the information encapsulated in the basic sequences making up DNA that is independent of the developmental process of that organism. More simply, we could say that the ontogenetic development of the organism *is* the model of interpreting the genome. The model of the genome as independent from context is thus the product of a biological fantasy.

With reference to man, as Oyama informs us, epigenetics can help us to understand that it is the multiple ways in which human beings *become* in specific contexts (natural, but also social) that define what a human being is. Skills are not predefined and do not have an essence independent of performance. Like all organisms endowed with a body, human beings construct the environmental conditions for their development and those with whom they interact through their actions. Organisms are thus not only passive *loci* of change but creative agents that establish change through action and the experience of the surrounding world. To deny experience would mean denying the nature of organisms.

The paradigm outlined thus begins from an ecological perspective that sets the biological organism in its entirety and in mutual relation with the surrounding environment at its core. This is a bottom-up model that, refuting the informational and top-down model of genetics, assumes the mutual ontogenetic and relational ‘co-building’ of organism and environment.

At its roots lies a radical refusal of the Cartesian body/mind dualism and of any kind of its re-proposal in a new guise. DNA is not defined as a code from which it is possible to read life,

but as a plastic entity that is sensitive to external changes resulting from the organism-environment interchange. The main theoretical outcome of this picture is that the genome is a locus of potential that illustrates the creativity of living systems. This is a creativity that is implemented above all by means of the development of constructive skills employed to modify the environment based on the intentional (non-deterministically programmed) action of material (physical) embodied organisms.

Concerning human and social sciences, it is possible to hypothesize a transfer of this paradigm onto a cultural plane, to show how knowledge also should not be considered an informational code that deterministically guides human behavior, but as the fruit of a constructive action based on abilities ripened through experience in the course of involvement with the natural and social external environment. Culture thus proves also to be the fruit of know-how associated with the skills produced ontogenetically by our bodies, through performative experience with the external world.

6.2.2 Skilled experience in terms of socio-anthropological given

Chapter 4 applied this principle to one particular product of human culture, that of technology. The objective was to address the question whether it is possible to consider the advent of modern technology a process that has weakened the relationship between corporeal experience and material reality. Undoubtedly, this is fairly frequent topic in contemporary philosophical and sociological analysis of technology.

It has been shown that human culture is not just a mere package of information, rules and representations (the so-called 'cultural models') distinct from and independent of their practical application in real contexts of action. On the contrary, knowledge, and with it culture, should be considered as permeated by the real practice of doing, constructing, experiencing. The argument proposed here is that knowledge is not only expressed by practice, but is also and above all constantly (re)generated thus. Knowledge is *always* practice, and it is *inextricably* linked with ability. These abilities are not formalized in rules, instructions or informational codes, but are the fruit of repeated and often tacit corporeal performance. I refer, therefore, to a *know-how* enshrined in the body. The movement of the

body is then a form of perception, at the same time as a way of acting in the world and a way of knowing it.

In particular, this paradigm is applied to that particular form of cultural expression known as 'technicity', described here as an indissoluble interweaving between environment and body (organism). I sought to demonstrate that technical action is an emergent property of the process that involves tools, gestural expressiveness and matter in a determined time and space of a real and intentional *being-in-the-world*. In this context, the centrality of skill in technical action is revealed. The paradigm as applied here shows that skill should never be understood as a property that may be traced (effectively reduced) to a single organ of the body (such as the hand), or, for that matter, relational property (e.g., hand-eye coordination). It is, instead, the expression of the interaction between the organism in its entirety and the environment (natural and social). This allows for disposal of the prejudice that defines only the traditional technical action as skilful, envisaging this as the use of a tool by a specific organ (or relational properties as such).

This insight is central to the argument that, albeit in a different way, the most evolved technology still demands the deployment of a broad set of abilities that are both corporeal (albeit not only manual) as well as social. This is a key point in the conceptual restoration of technology back within the field of activities that require (bodily) experience and sociality. This also serves to challenge the 'techno-pessimist' theories that, in asserting the radical autonomization of technology from society and the human, call into question the relationship between technology, experience and sociality.

6.2.3 Skilled experience in terms of socio-political opportunity (challenging and democratizing technical codes)

It is undeniable that modern technological development has extensively diminished the role of skills in technical action. The question, however, that has guided and that represents the key issue prompting this work, is that of whether there is room for manoeuver that may lead to a new expansion of the role that skills play in technical action.

Indeed, insofar as we have established the principle that skill cannot disappear, since it is ontologically inherent in action in general and technique in particular, then an understanding

of how to facilitate its recovery and revalorization may seem to be implied as a valorization of human experience. It was in this context that Chapter 5 attempted to answer the question of whether there are practices of technological development that may concretely retrieve human skills in processes of technical innovation.

Although always interwoven in all the known technological processes, it is argued, experience, sociality and skills can be enhanced in concrete terms, and by a number of specific logical and technological practices. In particular, the logic and practices of *open source* were discussed, in order to demonstrate how it is a domain that it is particularly well suited to an enhancement of this fruitful interweaving. In point of fact, *open source* is founded on socially constructed skills precisely because these are developed in practices of the sharing of common goods (for instance knowledge). Attention is drawn especially to the case of applying *open source* to the new 'life technologies' with specific reference to agro-biotechnologies – widely regarded as hegemonically determined – in order to illustrate that there are very significant margins to recuperate a wider involvement of experience and social participation.

It is shown that there is an opportunity to establish widespread *re-skilling practices* able to re-embed technological production within expert social skills. As discussed, this clearly concerns skills that are less bound to the physical and material dimension of the body and more to its immaterial and social quality. Nevertheless, and this is important to emphasize, the body does not vanish, it always remains the prime instrument of mediation of technical action on the world. This is not a body limited exclusively to the skill or power of the hand – although note, e.g., the dexterous manipulation by fingers of the touch-screen, a recent, quickly disseminated and very widely developed and still developing skill-set - but is a body that remains present and decisive, as Sennett has demonstrated.

A crucial point emerging from the fifth chapter regards the set of political implications linked to this transformation. In particular, the effect that *open source* may have on Feenberg's process of 'democratic rationalization' is discussed. The chief merit of this derives from the process of opening and transparency of the technical codes encapsulated in technological devices. These are codes that technocrats consider ideologically neutral, the results of exclusively technical processes that are rational and efficient, but which in truth, also

incorporate hegemonic social codes. This opening and transparency adds nothing to the social nature of these codes, which is always and nonetheless present, but it does crucially contribute to rendering such socio-technical codes available, accessible to society as a whole and no longer exclusively to an opaque and politically irresponsible technocratic elite (irresponsible in the sense that it is not accountable for its actions to society as a whole).

This may be summarized graphically with another version of the same semantic map (Figure 5)

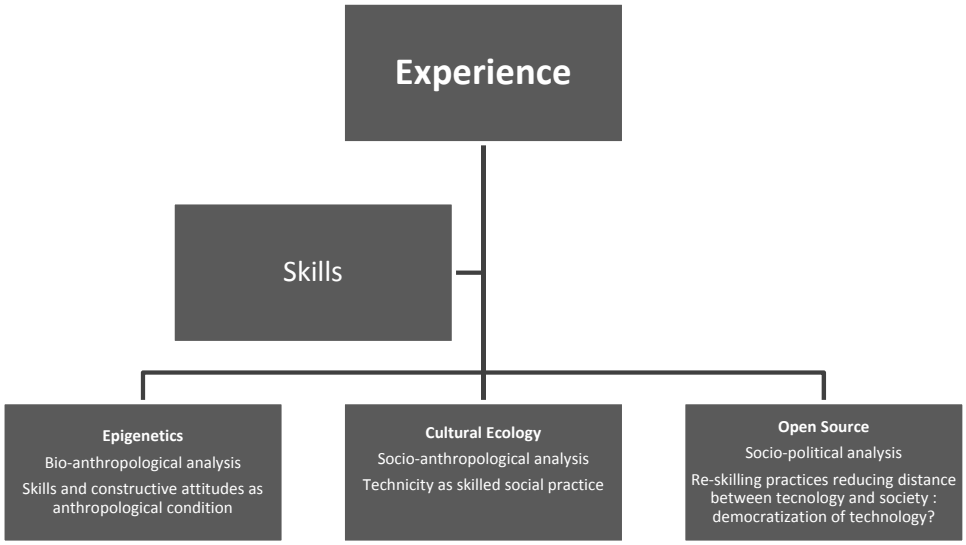

Figure 5. Representation of semantic map presented (three realms)

Summarizing, this thesis proposes an alternative gaze at the society-technology interrelationship stemming from a general reflection on their relationship. This is a controversial relationship that has provoked a heated debate over the past half a century or so with and among various currents, schools and disciplines. The objective I regard as significant from the scientific standpoint was to make a cross-disciplinary contribution aimed at showing how these two entities (technology and society) need not (cannot) be

considered as separate and opposing, as is often and widely explicitly and implicitly assumed.

The objective may be reached by showing how human experience has always played a fundamental role in defining technicity with the implication that no element in the sphere of technology, even the most advanced, can do without human experience. In order to show this relationship, I have used unit skills in connection with the bio-anthropological statute of man and related these to technical action as a starting analysis. Indeed, skills have the merit of constituting an essential part of human experience while, at the same time, being firmly embedded in the social dimension of human action. Our thesis seeks to assert, syllogistically, that:

a) Skills are socially characterized (starting premise)
b) There is no human action without skills (chapter 3)
c) There can be no technical action without skills (chapter 4)
d) There is no technical action without sociality (closing assumption).

If there is no technical action without sociality, then, in reality, there can be no technology without society. Our premise is that even to the extent that social and technical interweaving has been progressively weakened, the gradual autonomization of technological progress directed by developments in the most advanced technology has not entirely been pulled apart. It is noted that autonomizing developments have led some authors to believe we are facing a change of epochal paradigm, in which the technological is uprooted from the social once and for all and thereby - fulfilling the Heideggerian prophecy. It is in order to show, instead, that in today's age also, it is not possible to suppose such a definitive uprooting and that, on the contrary, recent developments might favor a radical change of direction, indeed a strengthening of the link between technicity and sociality and therefore a bringing together of technology and society that I have discussed the emblematic role played by open source (Chapter 5).

As often stated, the development of modern technology has certainly represented a heavy blow to the autonomy of the creative potential of human action. Nevertheless, it is argued, it is not possible to assert that modern technical action has been stripped entirely of the support of

such abilities. Human skills are an irreducible (Sigaut) and ineliminable element of human action because they are bound to the biological (Chapter 3), corporeal and social (Chapter 4) dimension of human experience. From this perspective, any technique or technology requires a creative participation founded on skills and practices are both corporeal and social (in this sense, any nature-culture dualism is of little importance). This profound principle is at the heart of the pragmatic materialism informing this work. Naturally, there are techniques or technologies that leave a lesser or greater margin to human skills, but these (human skills), I reiterate, cannot ever be cancelled out.

As a scientific position, this has a political implication that is by no means minor: there are significant margins for a valorization of such skills with the aim of augmenting processes of democratization of production and technological transformation. Such margins may envisage interventions from a productive, organizational, technical and social point of view, interventions in which practices of participation and sharing in deliberation and decision making may have more room to contribute to the process of technological creation. Open source represents an important emblematic case heading in this direction (Chapter 5), but it still raises with the force of empirical evidence a fundamental issue that contemporary society cannot pretend to ignore: fundamentally, technical and scientific knowledge should be considered common assets and as such they impose a socio-political and ethical reflection on the opportunity for a democratization of technology.

The assertion that technical action can never exclude experience and hence skills requires the employment of a philosophical language to affirm a sociological fact, because experience always implies sociality. Experience is never only an individual or subjective entity. It is certainly corporeal, but implies an open corporeity that is saturated with relationality, with connections to the natural and social environment surrounding it. Recognizing, as, for instance, Feenberg does, that technological rationality is and must always be characterized by human experience, means establishing an essential maneuvering-room for social participation that can regulate, limit or change such rationality.

6.3 General discussion and questions for future research development: technology and participation

The concluding chapter of this thesis - and more generally, the issues it implies related to the opening and transparency of hegemonic technical codes - warrants further future research. More generally, the issue of democracy in relation to technology represents one of the most important challenges that late modernity presents to us. The technologically advanced world as we experience it demands deeper reflection in respect of this issue. In the end, the very future of democracy in our societies is at stake. I do not mean here to refer to democracy from an institutional standpoint, as a form of state-structured governance, or mere methodology of political selection, but rather in terms of a deeper notion of participation. It is this I wish to propose as a guiding and important path for reflection and its further development. I do believe that this development might touch on various issues as elaborated through different research projects.

It is not possible to discuss these here to any depth, but what I will try to do is outline a *map of elements* that can represent possible fields of future research. At the end of the chapter, I will present these elements as a matrix indicating a general battery of research questions.

6.3.1 – a) Reciprocity as social code in technology development

The first issue presented as a proposal for future research focuses on *'reciprocity'*. Actually, it seems that reciprocity represents the key-factor of open source relationality. As Karl Polanyi (1944) has amply illustrated, there are three main mechanisms of social reproduction allocating insufficient resources to satisfy needs: the market, redistribution and reciprocity. The market is a process of optimization based on exchanging goods with goods and services according to an abstract value of equivalence represented by a price; redistribution allots resources on the basis of a principle established by the authority; reciprocity is a principle of economic and social regulation based on the relations through cooperation and gift exchange. Open source is grounded entirely within this latter mechanism. Here, unlike what happens in the market, the relations are not neutral. On the contrary, they are founded on a social bond, a bond based on the social characteristics of the subjects involved (as is commonly said in sociology: it is contextual and socially oriented).

The French anthropologist and author Marcel Mauss showed the social characteristics of these relations with the greatest persuasiveness. In particular, he demonstrated how reciprocity represents a particular form of exchange characterized by a collective nature, by objectives that are not purely utilitarian and, above all, by the fact of being inserted within a set of social obligations. Indeed, cooperating subjects are not engaged as single individuals, but are obliged, exchange and bargain in the name of an interest and a collective moral duty of a general nature. In the reciprocity, by virtue of a logic guiding exchange with a principle of ethical and non-utilitarian nature, the act of exchange has a value in itself of equal importance to that of the object being exchanged.

This does not imply an absence of usefulness, just as it does not necessarily mean a lack of charge. In reciprocity there is a useful dimension and there is an exchange (of goods or services). The specificity lies in the fact that cooperation based on reciprocity envisages a threefold obligation: giving, receiving and giving back. The deferred restitution (hence uncertain in time and amount) has the effect of setting the basis for the formation and consolidation of the social bond. Non- economic and non-utilitarian factors such as trust and the willingness to offer and give back are fundamental elements.

As discussed at length in Chapter 5, free software and open source answer these criteria. In this sense, they are evidence of a new engagement of technological innovation in the pronounced social dynamics of reciprocity. This aspect deserves further examination in future research proposals that may develop its profound implications. One research might be to analyze the mechanisms of this re-encapsulation of the technological in the social sphere. Such a process can only take place through the practice of re-skilling, namely through practices that enhance the value of human experience (understood as shared experience) in technical action. A novel and potentially revolutionary aspect of this in the case of open source is that it enables and involves these practices developing and extending the role of experience beyond scientific laboratories and, more generally, technocratic institutions. Such a broadening, perhaps even more significantly, operates as an alternative to and block on the colonizing of the field of the simple use of technology, and, moreover, even the sphere of technological production and innovation. These are the places that today, more so than before even, must be investigated.

From this perspective, the typically STS approach that looks to research laboratories as the privileged places for investigating social practices, could give more room to research that may break free from these (by now narrow) enclosures. Open source therefore potentially unlocks the code of technology that incorporates the dictates of hegemonic culture in order to make it accessible and adjustable by means of shared and socialized expert practices. In this way, 'society' makes an incursion into the sterile sanctuary of research and innovation. This event removes the veil of hypocrisy that in traditional scientific rhetoric asserts the independence and autonomy of science in the laboratories from the 'external' social world.[124]

6.3.1 – b) Opening the laboratories and the emergence of re-designers

STS studies have already demystified the ideology underlying such rhetoric, showing how the work carried out in laboratories is socially influenced and influenceable. STS studies have had the huge merit of shedding light on just how far the social can condition the practices of laboratories, institutes or research networks. Today however, the open source movement, from a highly critical standpoint towards changing the relations of the status quo, claims the moment has arrived in which 'the society of the few', which until now has inhabited the scientific laboratories and knowingly or unwittingly transferred hegemonic social and cultural coding in the technical code of the objects, is giving way to 'the society of the many', with all its needs and utopias. Along such lines, a proposal of future research consists precisely in analyzing the opposite movement to that analyzed by STS studies and which has represented their most original hallmark. *Indeed, after having widely analyzed how society has made its way into the laboratories, it is now high time to underpin a reflection on how the 'laboratories' (practices, protocols, etc.) are undergoing a process of social 'spreading', becoming dispersed and decentralized outside research institutions.*

The open source movement would thus be in step with those who for years have maintained the need to democratize science and technique by means of broadening the network of participation in technological production. Seeking a path of genuine development (people-needs as opposite to capital-based), for example, Ruivenkamp (1997) has defined *re-designers*

[124]For all these reasons, it is my belief that the open source experience is emblematic and may illustrate that a) technology and society are not two separate entities, and b) advanced technology is in a position to close the gap between the social and technical brought on by the advent of modern technology.

as those social actors who are not limited to acknowledging that biotechnologies (like all technologies) are the fruit of interaction and co-creation of biotechnologies and other processes. Indeed, they believe it possible to influence such interaction. Re-designers seek to create room for manoeuver within which other socio-technical combinations, other forms of biotechnologies can be developed[125].

Re-designers are also realistic. They well know that the genome and biotechnologies are developed inside global power structures, yet they believe that this does not mean that biotechnologies should inevitably be developed exclusively to serve the interests of multinationals.

The re-designers consider it a challenge to investigate the extent to which the development of biotechnologies may be in line with other social interests. This makes them builders of networks, always on the look-out for those with whom they can work to provoke social and technological change. They set the scientific development of biotechnologies and the genome directly within social processes and seek to free them from the global system of bio-powers, transforming them into a catalyst of specific local development.

As we saw in Chapter 5, assuming the perspective of re-designers with reference to agricultural science and food production, the open source movement is also seeking take up a position at the centre of an attempt to change the technical and social dimensions of biotechnologies. In this sense, the open source movement (or at least part of it) is like the bearer of a revolutionary vision that aims at replacing practices of dominion and exclusion with new practices of sharing and inclusion. Obviously, the movement must still prove itself to not be merely replacing one rhetoric with another: it must be able to broadly handle the contradictions that still characterize it, as we mentioned (Chapter 5), which gives some urgency to the investigation of other crucial aspects related to a democratization of technology.

[125] Despite their diverging views on the value of biotechnologies, both the champions and opponents of this technological development agree on supporting the theoretical premise by which biotechnology can be seen as an instrument with positive or negative consequences for society. In other words, and this is crucial, both separate biotechnologies from the social context in which they developed.

6.3.2 – a) Human experiences and skills as catalysts for a re-codification of technology

This thesis has presented the connections between biological and anthropological dimensions in a rhizomatic fashion and moved thence to discussion of the socio-political implications of this, the main objective being to show how our biological nature, just like the socio-anthropological, is fundamentally oriented towards the production of skills and creative abilities that are not determined by predefined codes (genetic or cultural). The material 'doing', physical or cognitive, characterizes our way of acting in the world, and, it is argued, the most advanced technological development does not necessarily imply our alteration. Put simply, technological development does not imply our transformation into passive beings or, in any case, beings destined to submissively use objects that encapsulate a what may be dubbed a 'technical hetero-direct code', as a hegemonic vulgate postulating the separation between technology and society would claim.

Without wishing to overstate the case – by naïvely emphasize miraculous virtues or failing to recognize critical limitations and entanglements – I would wish to emphasize the important potential of open source to reconcile technology with society, opening up the former (its technical code) to the latter by means of the skills of users. In this sense, the argument comes full circle to the philosophical and sociological debate introduced in Chapter 2, representing the departure point and background of this work.

Indeed, orthodox Marxism does seem to postulate the neutrality of technique, or rather the idea according to which there are no right or wrong technologies in themselves, since what makes them right or wrong is the ideology guiding their uses.[126]

Feenberg has shown that within the neo-Marxist thinking that criticized Heidegerian essentialist determinism in the 60s and 70s – which the American philosopher defined as the 'left dystopians' (for instance, the thinking of Marcuse) - there is an apparently incurable ambiguity. On one hand, they connect again with Marxist tradition by refuting the essentialist nature of technology, and therefore recognizing its autonomy and neutrality, while on the other, they postulate the subordination of technology to the ideological matrix that historically dominates a certain society. By which for instance, according to this interpretation, there are

[126] Trotsky was to radicalize this principle, asserting that Taylorism is bad if applied in capitalist factories and just when applied in socialist factories.

intrinsically capitalist technologies, namely developed within the capitalist economic and social system (for example the assembly line), and therefore destined to necessarily express and consolidate that particular order of social domination.

This vision drastically reduces the remaining possibilities of change or democratic transformation of technology. In the wake of this interpretation, an author like Ivan Illich (1973) has theorized the contrast as between industrial technologies, intrinsically capitalist and therefore necessarily aimed at exploitation, and 'convivial' technologies, namely tending to facilitate and based on communication, cooperation and interaction. This interpretation was highlighted by André Gorz (1980: 40) when he wrote that the means of production are not simply neutral machines since capitalist relationships of dominion are inscribed within them.

In my view, it would be interesting to develop this aspect further, investigating how and whether open source may conceptually mend this contradiction, giving life to a theory and practice that shows the possibility of shared and widespread interpretative practices of a particular technology. In other words, even if it is true that a certain technology is never created neutral, but is ideologically conditioned, is it possible that this technology may be the object of cultural re-interpretation? Nothing is deterministically branded. With the term 'cultural' I do not mean that this re-interpretation is only conceptual; on the contrary, I believe that it must be grounded in shared and widespread material practices. Clearly, such practices demand certain skills and interpretative struggles between different social subjects, struggles in which there are obvious asymmetries of power between the subjects involved, but in which the outcome is never a foregone conclusion, and rather depends on the action and the participation of everyone.

We are therefore speaking of non- determined processes, open to various possible developments. The historical trend of computer science and, above all, the Internet shows just this. Emerging in a libertarian context impregnated by a culture of sharing and exchange, it has developed from an instrument of military domination, to become a battleground between a range of opposing spirits. The clash between the 'proprietary' model and 'open' model of technological and scientific development is, indeed, an emblematic example. [127] In the space

[127] For a broad overview of this, see also the recent text by Broca (2013).

created by this clash, one could hinge further interesting research projects to investigate re-interpretative practices.

It is also for this reason that Chapter 5 emphasized the topic of open source and, above all, the possibility of realizing a transfer of the shared model motivating it to different contexts from the one in which it has emerged and gained a standing, namely computer science. Obviously, we are referring to a potential so that, to be coherent with what has been stated thus far, it does not deterministically encapsulate the principles of its uses. We do need to be minded that open source does not evade processes of interpretation and, sometimes, of radical re-interpretation by users. At the same time, no technology is neutral, and there *are* ideological principles and political interests embedded in the design of every product. The shared and democratic potential of open source therefore implies but does not dictate greater participation and democracy: such potential must constantly be cultivated, interpreted and applied.

This potential suggests an opening of the so-called 'technical code' of which Feenberg speaks. Briefly, the hegemonic culture written into (as) the technical code of every product (expressing a particular relationship of power between the social subjects of a given historical age) can be subjected to revision and transformation thanks to the open source model – at least, it can be subjected thus with greater facility and effectiveness than what is conventionally usual in the restrictive model of exclusivity. Indeed, the participation process enabled by the open source model allows for the introduction of mechanisms of 'technical creativity' directly within the technical code. The user's creativity generally lies in the skills developed in the framework of using the technology. This creativity is certainly important, but expresses a clear asymmetry of power between producer and consumer (user). Here, I refer to de Certau's theory on contemporary culture and its consumption (such as reading).

6.3.2 – b) Resistance and occupation of spaces of social creativity

Studying the practices of consumption and reinterpretation of texts, Michel de Certau (1980) acknowledged the user/consumer with a freedom and a power perhaps never recognized before by researchers. Despite that, he revelled in distinguishing between the concept of strategy and tactics. Strategies express calculations, planning, the will and power of structures (institutions, governments, corporations, and so on) that produce texts, objects, etc. Tactics,

on the contrary, express the resistance practices that consumers/users enact to oppose the bid for dominion by producers. Tactics express a condition of freedom and resistance, but also of inferiority. Strategies design the places (physical and immaterial) of consumption: the cities, the shopping centres, the media, etc. Tactics, instead, cannot be achieved except as incursions into the 'occupied territories' by producers of strategies and through the use of objects that have been produced by these. Just as guerrillas who organize resistance to dictatorial governments or occupying forces, consumers do not have their own territory and can only operate in the time and with the instruments they have not created, just as the resistance uses stolen weapons from regular armies of the oppressors (see Table 1).

Table 1. Strategies and tactics of resistance (de Certau, 1980).

	Subjects	**Practices**	**Places**
Strategies	Producers (governments, institutions, corporations, media, etc.)	Ideological planning, rationalization	Occupation of the space: physical or immaterial territories (construction, technological production, collective imagination, etc.)
Tactics	Users/consumers	Resistance by means of the extemporaneous use and re-interpretation of objects already produced (physical or immaterial)	Action in time, lack of own places. Raids into occupied places

With open source we are dealing with an advance of the resistance front of the consumer/user directly into the heart of occupied territories, namely those of production. And continuing the metaphor, this concerns the conquest of a key *bunker* that holds and thus freeing a fundamental portion of occupied territory. The metaphor of the 'occupied' territory is deliberately chosen here since, as we have seen, production and creation have always been an anthropological prerogative of man tied directly to the social nature of skills.

What we have witnessed in modernity has been the expropriation of the terrain of social creativity and its concentration into the hands of the major technocratic institutions. The power of resistance that has, however, remained in the hands of consumers (it is not true that it has been eradicated) has the possibility today of making a crucial step forward through the shared production models of open source. The liberation of territory implemented with open source concerns such an important portion as to potentially crack the historical strategy/tactics relationship. For the first time in a meaningful way, the liberation of territories by means of the open source model gives the *resisters* (users/consumers) the potential to shift from tactics to strategy, a participated, shared and newly founded strategy for the valorization of the social distribution of skills.

The most effective antidote to the autonomization of technology from society, consists, I believe, in the virtuous implementation of processes of the *greatest coverage and social sharing of technical skills*. In other words, technological production should be socialized *ex-ante*, with the aim of establishing the principles, the dynamics and social practices that generate it from within. This process of transferring know-how from an elite group of technology professionals to the majority of common citizens could, if opportunely guided, facilitate a decentralization of the choices and decisions that incorporate their ends and objectives in technological objects. This would constitute a virtuous model of *democratization and sensitization* that would surely help social reflexivity on the so-called impact of such choices and decisions.

The margins, limitations and characteristics of these processes of creative transformation, just as of the subjects (individual or collective) of which they are protagonists, represent many important contexts of possible future research. This transformation, moreover, insofar as it is able to expand the margins of the technical creativity of users/consumers and considerably limit the asymmetries of power between these and producers, does not only concern the narrow field of computer science. This is demonstrated by the possibility of exporting the participated and shared *bottom-up* model represented by open source in the most disparate contexts of techno-scientific production. We have seen this in Chapter 5 with reference to biotechnologies, but we could extend it to an any number of spheres. The social phenomenon of DIY is significant proof of this. To develop sociological research on this movement would be of great interest.

6.3.2 – c) The maker-movement and do-it-yourself technology

For a number of years now, a genuine social movement of great interest and importance has been active in this direction: the maker movement or maker subculture. This is an approach founded on the principle of open source creativity that applies new technologies to set out the principles of do-it-yourself culture (DIY). Organized on libertarian principles ('anarchy that works'), this social movement is also, as with the open source movement, subject to controversial interpretations that cut across the traditional left/ right political opposition. Indeed, it encounters fierce opponents and fervent supporters both to the left and right of the political-ideological spectrum. The *maker movement* promises the re-founding of a society of production as against the consumer culture that has characterized more recent capitalist development. Clearly, however, it does so in terms profoundly different from the old logic of assembly-line based manufacturing. Indeed, the main point of reference of the movement is the enormous potential of self-production (individual or collective) that the new technologies in an manner have made available.

The common spirit of this movement is captured by the dictum that technical creation (from the production of objects to the creation of life) is a process within everyone's reach. The use of open source materials and products unequivocally shows the inspiration of this movement, namely an emphasis on collaboration as the method and above all a willingness to facilitate a playful and creative relationship with technique. If we need an object-symbol of this cultural revolution that the movement aims to introduce, then the recent MakerBot 3D printer comes immediately to mind, hailed by many as the new industrial revolution for the 21st century.

The technological principle on which this is based well known: driving a mechanical instrument with the aid of software. It works like a classic printer but in three dimensions. Pass after pass, a nozzle shifts on three axes and deposits layers of material (often a synthetic resin) replicating a digital model until achieving the desired result. From a door handle to a bicycle, the production possibilities are potentially endless. This technology has prompted the development of a multitude of small creative firms, but has above all also become a vehicle of creativity for amateur makers. The world of free software has seen this innovation as a way to apply its values and practices to manufacturing mechanisms until hypothesizing the realization of the principle of popular re-appropriation of the means of production (a truly

innovative form of socialization) and of the radical democratization of industrial production - the ultimate objective being the abolition of the 'consumer society'.

Another example of the maker approach is to be found in the Italian 'Arduino board' produced in Ivrea in the 'bar of King Arduino', from which it takes its name. Sold for a small sum (approximately 30 Euros), this board can be connected to numerous tools and allows making a wide range of tasks: guiding a 3D printer, controlling a robot, etc. Its success derives directly from the DIY spirit inspiring it. Entirely open source, Arduino is the most evident symbol of the potential passage of the open logic of software production to that of hardware (open hardware). The plug-and-play card enables a 'democratization' of the technological production of hardware, making it within the reach of the many. The aim is to enhance individual, social and collective creativity by favoring practices of creative exchange, with the intention of reducing the gap between producer and user, and avoiding the process of subordination of the subject to the technological object and, above all, to the powers of which it is bearer. Analyzing the processes connected to such creativity applied to hardware may be an interesting challenge for a future research proposal.

6.3.2- d) Democratization or aristocratization? Risks and challenges

Claiming to be within the reach of many clearly does not mean within the reach of all. Herein lies one of the more crucial problems, often highlighted by critical observers, namely the risk of hosting a kind of idyllic island occupied by a technophile aristocracy, proud of its own skills and separated from the rest of the social body. From this perspective, rather than representing a democratization process, the advent of open source would thus be a sliding towards a situation of further fragmentation, with on the one hand, producers with their power, and on the other, a mass of passive users who do not have the time, desire and/or know-how to participate in the process of technological production, with in the middle, a 'resisting' élite that may gain from this situation.

The problem exists and cannot be avoided, but rather than ignore it or else concede, assuming this to be the definitive demonstration of the inadequacy of the 'democratic solution' of the open model, I believe it should be accepted as a challenge. It is undoubtedly one of the issues needing further inquiry. One research question to ask then is whether we are facing a 'nascent

state' of a phenomenon that is only at the beginning and could soon lead to a simplification of the processes of technological assemblage so as to be able to speak of technological *bricolage* - in other words, the utopian aspect of the *Ikea model* of democratization of design applied to technological development.

Again, it would be interesting to understand - as Sennett (Chapters 4 and 5) seems to suggest, even if the open source phenomenon were to remain confined to a narrow niche of users/producers - whether this would then do nothing more than reproduce the medieval structure of the handicraft workshops (*atelier*) in a modern vein, with a fragmented and diffused model of authority based on the prestige of masters deriving directly from craftsmanship and the transfer of skills. This is an idea of a society in which the power is based on *savoir-faire* distributed among 'artisan groups' having in common a handicraft model of work and whose authority is based exclusively on prestige and social recognition. This is not the utopian model of everyone as equals, but neither is it the current model characterized by the centralized dominion of big international and globalized players. It raises the questions of power and will as well as tendency and possibility still entirely open issues that we face today and which deserve further exploration.

The risk of a non-democratic sliding of the phenomenon raises another correlated issue meriting deeper investigation: *do-ocracy*. Open source philosophy evokes (often explicitly invokes) a strong conception of participation conceived of in the pragmatic terms of '*doing things*', so much so as to prompt the neologism: *'do-ocracy'*. According to the principles of do-ocracy, doing entails an organizational structure in which everyone can choose their role and tasks to perform independently. Decisional responsibilities substantially derive, therefore, from doing a certain job rather than being appointed or selected following formal procedures. The principles of such an organization of work and groups involve a non-authoritarian and non-coercive model of relations, a strong culture of participation and the essential value assigned to recognition as the main form of reward. This is an idea with significant socio-political implications: the classic idea of democracy, like modern principles of meritocracy, is substantially challenged. Once again, democracy is perceived not as a formal application of procedural rules (elections, competitions, etc.), but as the fruit of substantial and pragmatic processes of action and concrete participation.

The risks of such a simplified vision of participation ('if you want something done, then simply do it') are obvious: the forms of representation in complex systems, the disappearance of intermediate bodies (unions, parties etc.), the risks of *free-riding*, exploitation etc. Here, we are concerned with highlighting how the work ethics underlying this is grounded in the principle (emancipatory) of cultivating passion and interest. A principle that contrasts heavily with the ethics (Protestant) of capitalism of which Weber spoke and that would radically move modern societies, where gain and duty are the prime motivational sources of work. In the open viewpoint, therefore, it is the realization of the self that characterizes the main driving force of work.

This libertarian and anti-hierarchical vision, according to some authors (Gorz, 2003) is hardly compatible with the capitalist economy. In reality, an ambiguity that proves difficult to resolve is concealed within this emancipatory vision of the job: the search for autonomy in work could also be understood as the expression of an entrepreneurial need that in itself is not in conflict with capitalism. There is, for example, a rhetoric of autonomy that shapes the transformations of the organization of the work and managerial practices of firms. Often, this rhetoric is only applied to creative activities and is primarily aimed at stimulating the productivity of workers, augmenting their exploitation in order to boost the firm's profits. [128] Ultimately, this concerns issues that made their appearance in the 60s (see for example Marcuse) and that still exist today in sociological and psychological practices applied to the personnel management of capitalist companies. Using classic Marxist categories, it would seem that the emphasis on qualitative dimensions linked to autonomy and self-realization may have a positive effect on the sense of alienation, but a negative one on exploitation. It is manifest that open source may well not be a sufficient condition for change in the economic-social paradigm.

Moreover, some of the most fervent detractors of this technology and of the philosophy supporting it come from the ranks of nostalgic supporters of the workers movement.[129] In

[128] An example is the Google's request of its employees to dedicate up to 20% of their working hours to personal projects but without reducing the duties to be performed. This leads to a work overload and a 'creative' stress, all of which is aimed at developing entrepreneurial ideas that the company then annexes, as it were. The workers have the sensation of having wide margins of autonomy, but in reality they give themselves over to exploitation.

[129] See e.g. the article in *Le Monde diplomatique* of January 2013 by Johan Söderberg, sociologist of the Institut Francilien de Recherche, Innovation et Societé (Ifris), with the eloquent title: *Illusoire émancipation par la technologie*.

particular, they make the claim that self-produced digital machines might be the direct descendants of the same technology that has led to the destruction of the industrial workforce (namely the computer). The main criticism centers on the fact that the makers are not the heirs of the labor movement, but rather the historical outcome of the negation of this – to the extent that the main figures of the maker movement come from MIT, an institute that has played a determining role in the creation of digital technologies. The chief limitation highlighted by the critics is that these technologies, far from sustaining the human and economic liberation of workers, would support a kind of self-exploitation, since the innovations created by single producers who lack bargaining power compared to the major multinationals would end up by swelling the profits of the latter. Moreover, self-production would result in the creation of a form of unfair competition with respect to the mass of traditional workers with consequent wage squeezing. Self-production, it is thus argued, would cause mass lay-offs and a general lowering of workers' earnings.

6.3.3 General intellect, commons, mutualism

Over the last few years, the open source movement has also been supported by the thinking of a number of authors who are critical of capitalism and the processes of globalization. Though not a direct expression of that world, they have found in open source thinking and practices and in DIY an important innovative potential. In particular, these intellectuals have sought to integrate such potential to a more general criticism of the transformations of capitalism, the new forms of work and the obsolescence of the model of social compromise that has characterized all advanced capitalist societies of the post-war period. The two perhaps most internationally renowned exponents of this group of intellectuals are André Gorz and Toni Negri. Albeit highly different authors, they seem to have common ground in the so-called 'general intellect'.[130]

Without going into detail, the main hypothesis of the 'general intellect' theorists follows the idea that today productive forces are becoming freed from capital because the heart of the production of wealth is the so-called *living labor*. The creation of value increasingly resides in the subject at work rather than in the exploitation of 'dead' knowledge, in so far as the wealth of firms (and nations) depends on the cognitive and relational attitudes of the workforce

[130] Here, the concept of *General Intellect* introduced by Karl Marx in 'The fragment on machines' from The Grundrisse (1857-1858) is central.

(provocatively named the 'invention-force'): things like creativity, intelligence and cooperation. All attitudes created and developed in non-working contexts (family life, social sphere, leisure, etc.), by means of a process of progressive colonization and exploitation of the social times of the individual.

According to this hypothesis, regarding 'immaterial work', capitalism has generated a major contradiction. Immaterial work cannot be pigeon-holed and programmed since it thrives on innovation and constant creativity. Mobilizing all the faculties of the subject throughout all the stages of his lifetime, it is developed outside the workplace. Nevertheless, capitalism persists in exploiting the wealth it produces in a parasitic fashion. The main instruments to implement such parasitic exploitation are precisely the copyright and the patent (Chapter 5). Other contradictions derive from this: in the first instance, the impossibility to normalize immaterial work within the legal and economic forms of the private wage-earning work; secondarily, the problem of measuring of work productivity, since individual contributions to the collective result are no longer directly quantifiable.

Here, open source represents the living embodiment of the characteristics of new forms of productive forces, of the contradictions they embody and the potential for social transformation they open up. In particular, this shows how parasitic capitalism continues to extract value through the privatization of bio-political production based on common goods, an open field in which living work moves in an independent way (Negri, 2006: 91).

On the basis of this analysis, I would ask whether the transformative potential implicit in open source does not, in fact, call into play a social model perhaps too quickly considered anachronistic.

It was Proudhon who has the merit of having elaborated a system of thinking that, precisely due to the development of open source logic and technological practices, may today enjoy a certain vengeance on those who once considered it a minor line of inquiry. In truth, his model was extraordinarily ahead of the times. The third way[131] of the libertarian socialism of

[131] The term "third way" has been used in politics to indicate various and often highly dissimilar things. In Italy it was likely used for the first time at the beginning of the 20th century in contexts of the arising fascist movement then arising and referring to the elaboration of an alternative political, cultural, social and economic system to the capitalist and communist; thereafter, it was re-formulated

Proudhon (by many considered the true father of anarchism) forges a politico-social formula that challenges both bourgeois capitalism as well as state communism. Recognizing neither God nor Master, Proudhon raised the alert to the dangers of a dogmatic Marxist communism which was perilously exposing itself to a new idolatry of power that would have the exploitation of capital replaced by that of the state. In this sense, Proudhon prophetically anticipated the disasters of Soviet communism and real socialism.

The social model that Proudhon supported was founded instead on *mutualism*. In biology, mutualism is a type of harmonic symbiosis in which cohabiting species draw mutual advantages from the reciprocal arrangement of their communal life. In the socio-economic field, mutualism is consequently a relationship of reciprocity between individuals and/or associations of individuals structured fairly on 'equal duties and equal rights', thereby uncoupling the subordination that characterizes the individual-state relationship. Favorable to the concept of property, understood as personal possession and usufruct,[132] and to the free interchange of goods between producers, Proudhon's mutuality had as its goal a free society, structured horizontally and equally.

Proudhon did not believe that the state could be the representative of the general will (Rousseau's social contract). In his view, individual commitment must remain the cornerstone of community life. His community federalism, in this sense, goes against any centralized and impersonal system, whether public or private, which always ends up by degenerating into authoritarianism and the illegitimate appropriation of the fruits of social work. Proudhon's political hypothesis, founded on mutualism and cooperativism, foresaw a society in which the individual is both producer and consumer at the same time, citizen and prince, administrator and administered. The relevance of Proudhon today seems invigorated by the blooming of various issues and social and political allied to this thesis: such as microcredit, common assets

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again in Italy by the politician, journalist and partisan Pietro Ingrao to indicate the presence within the Italian Communist Party of an alternative political road to both the soviet-styled line of Cossutta and the gradualist one of Napolitano (current President of the Italian Republic). The expression has also more recently been used for *Blairism*.

[132]The celebrated phrase 'property is theft' was successively embraced by communist Marxists to lend it a sense that was not expressly intended by Proudhon in his *Qu'est-ce que la propriété?* Here the thinker of Besançon was referring to the property of the means of production that exploiting the *plus-value* generated by the pooling of human means, *de facto* expropriated workers from the fruits of their labor. Instead, Proudhon was favorable towards individual property (possession or usufruct) that represents a protective guarantee against the abuses of power by landlord or state.

and self-management - but the aspect that lends centrality to his thinking now lies especially in the success of free software and all its possible applications, including those deriving from it and not only in IT.

From the viewpoint of philosophical analysis or social epistemology, open source experiences might therefore be a fertile field of theoretical and empirical investigation. Studying the best real social conditions for the development of this third way and analyzing good and bad practices in the various sectors in which technology increasingly digs further into the field of development would appear to represent a major and interesting line of research for future exploration.

6.3.4 New technologies, new organizational challenges: towards open source unionism?

A fundamental aspect deserving in-depth research along such lines regards the political forms for the organization of such experiences. It seems important to analyze the limitations and opportunities of this. With reference to the movement looking towards open source creativity, there is a need to further examine its various aspects and implications. As a case in point, a number of the considerations previously reported and upheld by envoys of the labour movement, merit investigation. These regard not only the specific case of the MakerBot 3D printer, but may easily be extended to all the innovations that, in the various technological domains, bring the shared logic of open source into play.

More generally, a contrast seems to be taking shape, entirely on the left from a political standpoint, between the interests of the traditional workers' movement and those of the new libertarian groups that see in new technologies an important instrument to free-up the energies and creativity of individuals and small communities of shared production. The issue at hand regards the possibility of these small communities representing a valid counterbalance to the power of multinationals, big corporations and the state in defense of the interests of their own supporters. The risk is that of crushing the political resistance to these great powers. The fear is that of leaping into the void with respect to the traditional and by now reassuring forms of organisation of the less powerful groups of society (for instance, the unions).

Obviously, one may readily object that such organizational forms of work and society are already going through a radical transformation and that it is necessary, therefore, to discuss the internal innovations it may be opportune to introduce to adapt to the radical changes that society and culture face. While recognizing the legitimacy of the fears indicated, however, the impression is that there are strong cultural oppositions within these organizations allied to both the traditional left and the right that are heading in an alarmingly conservative direction.

In those places where the crisis of trade-unionism has reached its peak, for example in the United States, open source logic has set forth possible innovative solutions. There is talk of a new 'open source unionism', an expression coined by Richard B. Freeman and Joel Rogers to outline possible new models of organization of workers based on practices of *membership* and *servicing* grounded in the use of the net and its related logic of sharing and exchange. This clearly means hypothesizing a radical transformation of organizational practices in the direction of modifying the meaning and forms of membership, changing the incentives and the relations of inner power and imagining in time new political and organizational strategies.

In particular, the adoption of a similar model would imply accepting the crisis and the overcoming of the current traditional form of representation: collective bargaining in favor of workers in contexts where unions demonstrate a majority support. In the open source model, similarly to the open logic of the IT world, the union should construct a language, practices and a common and collaborative platform between workers (often contractually flexible, politically diverse and geographically distant) and activists. The challenge is great, the outcome uncertain. The question is whether the unions will be able to grasp this challenge.
The impression is that the social and economic changes impose a radical change. At stake is the very survival of unions. In this paragraph, we suggest that an important line of social and political analysis could be developed on this topic. What are the risks and opportunities that open source unionism generates? And what are the political-organizational conditions needed to bring it about?

6.3.5 What kind of ethical governance for 'open source technology'?

Lastly, though no less important, the advent of new open source logics in the technological domain also compel critical reflection on the ethical implications of technological innovation.

Historically, the main agents considered legitimized to 'guide' technological development have been the state and the market. The growth of a greater sensibility to ethical issues applied to technology has favored the emergence of new figures to control techno-scientific development: *technology assessment* (*Technikbewertung*), the various deontological forms connected to the professions, the affirmation of the so-called 'ethics of technical acting' with all the various forms of ethical control of commissions, boards and so on. The results are in plain sight to everyone and are not, in my view, particularly encouraging. We may say that the successes are few and those partial and conflicting.

In truth, however, there has never been an authentic government of technology because technological logic has refused any kind of effective form of control and limitation. Scientific and technological research has become subject to such a wide and unquestionable process of social legitimization as to end up by transforming the very word 'research' into a *glittering generality*[133] able to 'externalize', from a cultural point of view, all the eventual negative effects it has generated. In other words, scientific and technological research has become an untouchable Moloch in a position to transfer the burdens and causes of its negative social consequences to politics, to the users and to administrators.[134] And a Moloch, as we know, does not allow 'fetters and chains' destined to limit its absolute power.

Today, new challenges seem to be emerging as a result of the start of processes of participated and widespread innovation. It is obvious that the horizontal spread of DIY and open source practices inevitably implies a fragmentation and dispersion of the centers of production and technological innovation. Such dispersion requires, in my view, a re-launching of the reflection on processes of ethical governance of technological production. The tendency to concentrate vertically, separate and deferred (ex-post) the ethical reflection on technological production creates a paradoxical dimension of incongruence and potential ineffectiveness with respect to an increasingly encapsulated and more diffused technological production at a social level. In

[133] A term created within the Institute of Propaganda Analysis (IPA) in the 1930's, 'glittering generalities' refers to emotionally appealing words so closely associated with highly-valued concepts and beliefs that they carry conviction without supporting information or reason. Such highly-valued concepts attract general approval and acclaim. Appealing to emotions such as love of country and home, and desire for peace, freedom, glory, and honor, they demand approval without examination and are typically used by politicians and propagandists. These highly abstract and ambiguous words/phrases are described at length by George Orwell (1946) in his essay 'Politics and the English Language'.

[134] The very idea of such consequences implicitly echoes the principle of an entity that is not born in the bosom of society even if it may cause certain effects on it (from without).

this sense, the more that open source applied to processes of technological innovation finds space, the more a reflection on the idea of a possible open ethical governance seems necessary.

Indeed, I would argue, the ethical challenges raised by open source concern the method and process of technological innovation rather more than single technological developments. Thus, it seems that the problem today is really that of finding or creating more institutions or specialist bodies to deal with the aims, limits or ethics of technology. On the contrary, setting up such bodies would only result in an acceptance of the erroneous assumption of the separation of technology from society and accentuate its effects. In other words, it would mean giving lifeblood to a self-fulfilling prophecy (Merton, 1949).

The question is whether this 'division of labor' is still a useful instrument, if there are margins in which the model can be revised. Are we sure that responsible innovation does not imply the end of the model of delegating responsibility to groups of qualified specialists? Is it possible to imagine the creation of open and participated spaces in which professionals and common citizens may reflect together on the ethical implications of techno-scientific development? Can we hypothesize a deliberative function of binding choices for these new entities? Is there a *techno-ethic-cracy* needing to be democratized? In general, it would be preferable were such reflection to be not only theoretical but also empirical; it would target possible techniques and platforms that might facilitate decentered processes of collective deliberation, practices of participated democracy and open source governance as applied to the ethical evaluation of technological innovation.

6.4 Critical Synopsis

Five critical knots are identified from the analysis of the debate developed on the theme of 'open source and democracy' that seem to emerge as particularly worthy of note. Presented in synoptic form in Table 2 (below), these represent as many potential contexts of research for the development of future lines of scientific investigation. With each critical knot linked to different a cultural context, though they are all clearly correlated.

This presents an overview of the main questions that critically define the outline of a theory of democratization of technology related to the advent of open source. Clearly this is by no means

exhaustive. It sets out research questions at an embryonic level that need further analytical development. Nevertheless, in my view, it pinpoints the very important critical knots, whose unravelling is a fundamental condition in order to really be able to speak of a new democratization of technological production. For now, it seems to delineate a condition that is simple but has important potential; since processes never come about independently, it is a good idea to extend this reflection if we wish to help this development.

In the first place, there is an anthropological dominion that we might also consider propaedeutic regarding others. Since it concerns the issue of reciprocity, on which other dominions depend in various way. Can we really consider, as various commentators have claimed (Berra & Meo, 2001), that open source is able to re-propose the structure of the social bond, characterizing cultures based on the model of exchange originating with the so-called gift, in a modern perspective? This is decisive, since all is said done, hypothesized and developed concerning democratization has its roots to a significant degree in this anthropological question that deserves exploring.

In the second instance, there is a correlated sociological domain. Here the issues to be developed concern the presumed capacity of open source to favor social processes of re-interpreting technology and creating social spaces of technical creativity by individual and (above all) collective subjects. Is this really the case? Are there truly these margins of creativity and interpretation? Is there, also methodologically speaking, the possibility of verifying such margins? Are they real?

There is then a political domain of the issue. The main questions here regard the effective force and pervasiveness of the process of distributing the choices and decisions that open source would promote. The debate seems to focus particularly on the real effectiveness of the mechanisms started and on the possibility that the open source model, favoring apparently greater decisional power, in reality conceals self-exploitive mechanisms. The Google case cited above and the theoretical examinations in Chapter 5 would point in this direction. Namely, that the margins of freedom and participation guaranteed by the open source model may only serve a greater productivity and creativity for the existing (albeit adapted) system to utilize at the expense of the creators.

A second political issue concerns the possible affirmation of a new split within the category of users. This would be a renewed version of a question consolidated within the context of the disciplines that are concerned with these issues. The problem regards the affirmation of a monopoly of technological innovation in the hands of a narrow elite of non-professional experts. In this sense, far from guaranteeing greater democratism, open source could be setting up a new selective elitism.

Finally, in the framing of questions by political order, there is a serious dilemma related to the inner dynamics of the practices and also the 'visions' of open source communities. The emphasis on 'doing' and the political importance (in terms of decision making power) that is recognized within open source communities raises no lesser problems of democratism (do-ocracy) concerning the patterns and traditional models that have been consolidated in modern Western liberal societies.

The socio-philosophical domain regards instead the possibility to really consider open source as the terrain on which the theoretical terms to realize a neo-Proudhonian mutualist ideal are defined. In other words, a condition of potential federalist neo-cooperativism that can be self-regulated in a distributed and participated way, free from the traditional modern and dual contrast imposed by the binomial state/market that has characterized much of the development of modern philosophical and social thinking. One may ask, moreover, if the theory of the common good, like that of the 'general intellect', can be a useful instrument in this direction.

The organizational domain concerns the radical impact that the development of open source practices could (further) have on the organization and legal management of the world of work. The democratization of techno-science and society also proceeds from this. The resistance and drive towards change reveal very interesting challenges, but also alarming grey areas on the rights of workers and the possibility to guarantee real participation in decisional processes and the protection of fundamental prerogatives. This applies also in the world of scientific research. The achievement of many of the opportunities for positive change (for workers) demands a radical change in the established models of representation in work places. Much research and analysis should be made in this area, traditionally little inclined to change.

The last domain concerns the ethical dimension of the problem. Processes of democratization of techno-science have certainly not been initiated by open source: there has been reflection on this issue for at least forty years. However, open source seems to be setting new challenges and new dynamics today, including from the viewpoint of the ethical governance of techno-scientific development. Indeed, just as in the case of the de-professionalization of the processes of technological innovation, the great democratic expectations created by the implementation of mechanisms of radical fragmentation and dispersion raise alarming questions about the risks of an ethical uncontrollability of these mechanisms. Put in perspective, a question seems to be forming on the horizon: in this picture of fragmentation and diffusion of techno-scientific innovation, is the classical model of recognizing ethical sustainability tenable? Can it still work? In other words, is the separation between bodies of ethical evaluation and common society still sustainable in a context in which the traditional separation between technology and society might be reduced until disappearing altogether?

Domains/Paragraphs	*6.3.1*	*6.3.2*	*6.3.3*	*6.3.4*	*6.3.5*
Anthropological	a) Is OS able to express a new 'anthropology of the gift' based on reciprocity?				
Sociological		a)Is OS able to encourage shared interpretative practices of specific technology? b) + c) Is OS able to promote tactics of cultural resistance and create spaces of social creativity?			
Political	b) Is OS able to favour the process of opening laboratories supporting the work of re-designer for co-creating technology?	d) Is open source a kind of new aristocratic tecno-elitism? Is do-ocracy a real democratic pattern? Does self-production favour a decentralization of choices and decisions ? Or does it support a kind of self-exploitation?			
Philosophical			Is it possible to favour a new kind of technology-supported mutualism against the traditional power of the state and the market ? Can we consider commons theory and practice a new context supporting this mutalism?		
Organizational				Which kind of new organisational forms of labour we need to adapt to these radical technological changes? And what fears and conservative pressures do we need to face? Is 'open source unionism' a feasible and useful tool?	
Ethical					May we imagine new open spaces and techniques for participative and deliberative practices on ethical issues? Can a model of 'open source ethical governance' work?

Table 2 Research directions linked to democratic implications of open source re-skilling practices.

General bibliography

Achterhuis, H. (2001), *American Philosophy of Technology. The Empirical Turn*, Bloomington and Indianapolis: Indiana University Press.

Akrich, M. (1992), The de-scription of technical objects, in W. Bijker and J. Law (eds.), *Shaping Technology/Building Society*, Cambridge (MA): MIT Press, pp. 205-224.

Apel, K. O. (1982), *Charles Sanders Peirce, From Pragmatism to Pragmaticism,* Amsherts: University of Massachusetts Press.

Arendt, H. (1964), *Vita activa*, Milan, Bompiani [en. ed.: *The Human Condition*, Chicago: University of Chicago Press, 1998].

Barcellona, P. (2005), *La parola perduta. Tra polis greca e cyberspazio,* Bari: Dedalo.

Bateson, P. (1988), The active role of behaviour in evolution, in M. Ho and S. Fox (eds.) *Evolutionary processes and metaphors,* New York: John Wiley.

Baudrilliard, J. (2005), *Violenza del virtuale e realtà integrale*, Florence: Le Monnier [en. tr.: *Violence of the Virtual and Integral Reality*, Toronto: York University, 2005].

Bauman, Z. (2005),*Globalizzazione e glocalizzazione,* Rome: Armando Editore [en. ed.: *The Bauman Reader*, Oxford: Blackwell Publisher, 2001].

Benkler, Y. (2006a), Commons-based peer production and virtue. *The Journal of Political Philosophy,* 14, 4, pp. 394-419.

- (2006b), *The wealth of networks*. *How social production transforms markets and freedom,* New Haven and London: Yale University Press.

Bernstein, N. A. (1996), On dexterity and its development, in M. L. Latash and M. T. Turvey (eds.), *Dexterity and Its Development,* Mahwah (NJ), Lawrence Erlbaum, pp. 1–244.

Berra, M. and Meo, A. R. (2001), *Informatica solidale. Storie e prospettive del software libero.*Turin: Bollati Boringhieri.

Bijker, W.E. (1995), *Of bicycles, bakelites and bulbs: Towards a theory of sociotechnical change,* Cambridge (MA): MIT Press.

Bloor, D. (1991), *Knowledge and social imagery,* Chicago: University of Chicago Press.

Boettiger, S. and Wright, B. (2006), Open source in biotechnology: Open questions. *Innovations,* Fall, pp. 43-55.

Bostrom, N. (2002), *Anthropic Bias: Observation Selection Effects in Science and Philosophy*, New York & London: Routledge.

Bourdieu, P. (1972), *Esquisse d'une théorie de la pratique*, Geneva : Droz [en. tr. : *Outline of a Theory of Practice*, Cambridge : Cambridge University Press, 1977].

- (1980), *Le sens pratique,* Paris : Les Éditions de Minuit [en. tr.: *The logic of practice,* Cambridge : Polity Press, 1990].

Bourdon, J. (2001) *Introduzione ai media*, Bologna, Il Mulino.

Braman, S. (1989), Defining information: An approach for policymakers, in D. M. Lamberton (ed.), *The economics of communication and information,* Brookfield, VT: Edward Elgar, pp. 233-242.

Bratman, S. (2001), *Health Food Junkies. Orthorexia Nervosa: Overcoming the Obsession with Healthful Eating,* New York: Broadway Books.

Braverman, H. (1974), *Labor and monopoly capital: The degradation of work in the twentieth century,* New York: Monthly Review Press.

Broca, S. (2013), *Utopie du logiciel libre. Du bricolage informatique à la réinvention sociale*, Neuvy-en-Champagne : le passager clandestin.

Broothaearts, *et al.* (2005), Gene transfer to plants by diverse species of bacteria, *Nature,* 433, pp.629-633.

Bucchi, M. (2004), *Science in Society. An Introduction to Social Studies of Sciences*, London : Routledge.

Bucchi, M. and Neresini, F. (2006), *Cellule e cittadini. Biotecnologie nello spazio pubblico*, Milan: Sironi.

Callon, M. (1986), Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay, in J. Law (ed.), *Power, Action and Belief: A New Sociology of Knowledge*, London: Routledge & Paul Kegan.

Capucci, P. L. (1994) *Il corpo tecnologico. L'influenza delle tecnologie sul corpo e sulle sue facoltà,* Bologna: Baskerville.

Castells, M. (1996), *The rise of the network society.* Oxford: Blackwell.

Cavalli-Sforza, L. L. and Feldman, M. W. (1981), *Cultural transmission and evolution: a quantitative approach*, Princeton-NJ: Princeton University Press.

Ceccarelli, S. (2009), Evoluzione, miglioramento genetico e biodiversità, in C. Modonesi e G. Tamino (eds.), *Biodiversità e beni comuni,* Milan: Jaca Book, pp. 109-128.

Ceccarelli, S. et *al.* (2007), Barley breeding for sustainable production, in M. S. Kang e P. M. Priyadarshan, *Breeding major food staples,* Oxford: Blackwell Publishing, pp. 193-226.

Clark, A. (2007), *Being There*, Cambridge (MA): MIT Press.

- (2008), Where Brain, Body and World Collide, in C. Knappett and L. Malafouris (eds.), *Material Agency. Towards a Non-Anthropocentric Approach*, New York: Springer, pp. 1-18.

Connerton, P. (1989), *How Societies Remember*, Cambridge: Cambridge University Press.

Cosmacini, G. (2003), *L'arte lunga. Storia della medicina dall'antichità ad oggi*, Bari: Laterza.

Craighero, L. (2010), *Neuroni specchio*, Bologna: Il Mulino.

Crary, J., Kwinter S. (1992), *Incorporations,* New York: Zone Books.

Damasio, A. (1994), *Descartes' Error. Emotion, Reason and the Human Brain*, New York: G. P. Putnam's Sons.

de Certau, M. (1980), *L'invention du quotidien*, Paris: UGE [en. tr. : *The Practice of Everyday Life*, Berkeley : University of California Press, 1984].

de Garis, H. (2005), The Artilect War: Cosmists vs. Terrans: A Bitter Controversy Concerning Whether Humanity Should Build Godlike Massively Intelligent Machines, Palm Springs (CA): ETC Publications.

Deleuze, G., Guattari, F. (1980), *Mille plateaux*, Paris: Minuit. [en. tr. *A Thousand Plateaus*, Minneapolis, University of Minnesota Press, 1984].

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

- (1927), *The public and its problems,* New York : Holt.
- (1930), *Individualism Old and New*, New York: Minton Balch.

Dreyfuss, R. C. (2003), Varying the course in patenting genetic material: A counter-proposal to Richard Epstein's steady course, *Advances in Genetics*, 50, pp. 195-208.

Eco, U. (1964), *Apocalittici e integrati*, Milan: Bompiani [en. tr.: *Apocalypse Postponed*, Bloomington: Indiana University Press, 1994].

- (1984), *Semiotica e filosofia del linguaggio*, Einaudi, Torino [en. Tr. *Semiotics and philosophy of language*, Bloomington: Indiana University Press, 1986].

Edelman, G. (1992), *Bright Air, Brilliant Fire: On the Matter of the Mind*, New York: Basic Books.

Epstein, R. A., Kuhlik, B. N. (2004), Navigating the anticommons for pharmaceutical patents: steady the course on Hatch-Waxman, *Chicago Working Paper Series*. At www.law.uchicago.edu/Lawecon/index

Feenberg, A. (1999), *Questioning Technology*, Routledge, London.

- (2003), Pragmatism and Critical Theory of Technology, *Techné*, 7:1.0

- (2005), Critical Theory of Technology: An overview, *Tailoring Biotechnologies*, vol. 1, issue 1, pp. 47-64.
- (2010), *Between Reason and Experience: Essays in Technology and Modernity,* Cambridge, MIT Press.

Foley, R. (1999), *Gli umani prima dell'umanità*, Roma: Editori Riuniti [or.ed.: *Humans before humanity*, Oxford: Blackwell Publishing, 1995].

Foucault, M. (1976), *Histoire de la sexualité 1 : la volonté de savoir*, Paris : Gallimard [en.tr. : *The History of Sexuality Vol. 1: The Will to Knowledge,* London: Penguin, 1978].
- (1977), *Discipline and Punish*, New York: Pantheon.

Fox Keller, E. (2001), Beyond the gene but beneath the skin, in S. Oyama, P. E. Griffiths and R. D. Gray (eds.) *Cycles of contingency. Developmental systems and evolution*, Boston: MIT Press, pp. 299-312.

Friedmann, G. (1955), *Industrial Society : The Emergence of the Human Problems of Automation*, Glencoe (Ill.): Free Press.

Galimberti, U. (1983), *Il corpo*, Milan: Feltrinelli.
- (2007), *Psiche e techne. L'uomo nell'età della tecnica*, Milan: Feltrinelli.

Gallino, L. (2007). *Tecnologia e democrazia. Conoscenze tecniche e scientifiche come beni pubblici*, Turin: Einaudi.

Gibson, J.J. (1977), The Theory of Affordances, in R. Shaw & J. Bransford (eds.), *Perceiving, Acting and Knowing*, Hillsdale (NJ): Erlbaum.
- (1979), *The ecological approach to visual perception*, Boston: Houghton Mifflin.

Giddens, A. (1984), *The Constitution of Society*, Cambridge: Polity Press.
- (1990), *The Consequences of Modernity,* Cambridge: Polity Press.
- (1991), *Modernity and Self-identity: Self and Society in the Late Modern Age,* Cambridge: Polity Press.

Gill, S. (2002), *Power and Resistance in the New World Order*, Palgrave: Macmillan.

Gould, J. L., Gould, C. G. (2007), *Animal architects. Building and the evolution of intelligence*, New York: Basic Books.

Gould, S. J., Vrba, E. S. (1982), Exaptation a missing term in the science of form, in *Paleobiology,* 8 (1), pp. 4–15.

Griffiths, P.E. (2001), *Beyond the Baldwin effect: James Mark Baldwin's 'social heredity', epigenetic inheritance and niche construction (modified 2010). At: http://philsci-archive.pitt.edu/446/*

Gorz, A. (1980), *Adieux au prolétariat. Au-delà du socialisme*, Paris : Galilée [en. tr. : *Farewell to the Working Class*: *An Essay On Post-industrial Socialism*, Boston (Mass.) : Pluto Press, 1982].

- (1988), *Métamorphoses du travail. Quête du sens critique de la raison économique*, Paris : Éditions Galilée [en. tr. : *Critique of Economic Reason,* New York and London : Verso Books, 2011].

- (2003), *L'immatériel. Connaissance, valeur, capital*, Paris : Galilée [en. tr. : *The Immaterial. Knowledge, Value, Capital*, Greenford : Seagull Press, 2010].

Gramsci, A. (1975), *Quaderni dal carcere.*Turin: Einaudi [en. tr.: *Prison Notebooks*, New York: Columbia University Press, 2011].

Gros, F. (1990) *L'ingénierie du vivant*, Paris: Odile Jacob.

Hacking, I. (1999), *The Social Construction of What?,* Cambridge, Mass.: Harvard University Press.

Hall, S. (1973), Encoding, decoding, in Centre for Contemporary Cultural Studies (ed.), *Culture, media, language: Working papers in cultural studies,* London: Hutchinson, pp. 128-138.

Hardin, J. (1968), The tragedy of the commons. *Science,* 162, 3859, pp.1243-1248.

Heidegger, M. (1927), Sein und Zeit, in *Jahrbuch fur Philosophie und phenomenologische Forschung*, VIII, Halle: Niemeyer, pp.1-438 [en. tr.: *Being and Time*, Albany: SUNY Press, 1996].

Heller, M. (1998), The tragedy of the anticommons: Property in the transition from Marx to markets, *Harvard Law Review,* 111, 3 (January), pp. 621-688.

Hess, C., Ostrom, E. (2007), *Understanding knowledge as a commons,* Cambridge (MA): MIT Press.

Hickman, L. (2001), *Philosophical Tools for Technological Culture. Putting Pragmatism to Work*, Bloomington: Indiana University Press.

Himanen, P. (2001), *The hacker ethic and the spirit of the information age,* New York: Random House.

Holt-Giménez, E., Patel, R. (2009), *Food rebellion*s. *Crisis and the hunger of justice,* Oxford: Pambazuka Press.

Hook, S. (1987), *Out of Step: An Unquiet Life in the Twentieth Century*, New York: Harper & Row.

Hope, J. (2008), *Biobazaar. The open source revolution and biotechnology,* Cambridge (MA): Harvard University Press.

Hunt, A., Wickham, G. (1994), *Foucault and law. Towards a sociology of law as governance,* London: Pluto Press.

Illich, I. (1973), *Tools for Conviviality*, New York: Harper and Row.

Ingold, T. (1983), The Architect and the Bee: Reflections On the Work of Animals and Men, *Man (N.S.),* 18, pp. 1-20.

- (1989), An Anthropologist Looks at Biology, Curl Lecture 1989 *Man(N.S.),* 25, pp. 208-229.
- (1994), Humanity and Animality, in T. Ingold (ed.) *Companion Encyclopedia of Anthropology: Humanity, Culture and Social Life*, London: Routledge, pp. 14-32.
- (1997), Eight Themes in the Anthropology of Technology, *Social Analysis*, 41(1), pp. 106-38.
- (1999), Tools for the Hand, Language for the Face: An Appreciation of Leroi- Gourhan's Gesture and Speech*, Studies in History and Philosophy of Biological and Biomedical Sciences,*30, 4, pp. 411–453.
- (2000a), Evolving Skills, in H. Rose and S. Rose (eds.) *Alas Poor Darwin. Arguments Against Evolutionary Psychology*, London: Jonathan Cape, pp. 225-246.
- (2000b) *The Perception of the Environment: Essays on Livelihood, Dwelling and Skills*, London: Routledge.
- (2005), Walking the Plank. A Meditation on the Process of Skill, in J. R. Dakers (ed.), *Defining Technological Literacy: Towards an Epistemological Framework*, New York: Palgrave Macmillan, pp 65-80.
- (2007), *Lines. A Brief History*, Abingdon: Routledge.
- (2008), When ANT Meets SPIDER: Social Theory for Arthropods, in C. Knappett and L. Malafouris (eds.), *Material Agency. Towards a Non-Anthropocentric Approach*, New York: Springer, pp. 209-215.

Jablonka, E., Lamb, M. (2007), *L'evoluzione in quattro dimensioni*, Milan, UTET [en.ed.: *Evolution in four dimensions*, Cambridge (MA): MIT Press, 2005].

Jacob, P., Jeannerod, M. (2003), *Ways of Seeing*, Oxford: Oxford University Press.

Joas, H. (2005), *The Creativity of Action*, Malden (MA): Polity Press.

Jordan, B. (2002), *Gli impostori della genetica*, Torino: Einaudi.

Kaczynski, T. J. (2010), *Technological Slavery*, Port Townsend (WA): Feral House.

Kadlec, A. (2006), Reconstructing Dewey: The Philosophy of Critical Pragmatism, *Polity,* Vol. 38, No. 4, pp. 519-542.

Kay, L. E. (2000), *Who wrote the book of life? A history of the genetic code*, Stanford: Stanford University Press.

Kloppenburg, J. (2005), *First the seed. The political economy of plant biotechnology,* Madison: University of Wisconsin Press.

- (2010), Seed sovereignty: The promise of open source biology, in A. Desmarais, K. H. Wittman (eds.), *Food sovereignty: Theory, praxis, and power,* Halifax (NS): Fernwood Publishing, pp. 1-15.

Kompridis, N. (2006), *Critique and Disclosure: Critical Theory Between Past and Future*, Cambridge (MA): MIT Press.

Koyré, A. (1948), Du monde de 'l'à-peu-près' à l'univers de la précision, *Critique*, n. 28.

Kranzberg, M. (1986), Technology and History: 'Kranzberg's Laws', *Technology and Culture*, Vol. 27, No. 3, pp. 544-560.

Krary, J., Kwinter, S. (1992), *Incorporations*, New York: Zone Books.

Kuhn, T. (1962), *The structure of scientific revolution*, Chicago: Chicago University Press.

Kurzweil, R. (2005), *The Singularity is Near*, New York: Viking.

Labriola, A. (1899), *Socialisme et philosophie*. *Lettres à G. Sorel*, Paris : Giard & Brière [en. tr. : *Socialism and Philosophy*, Charleston : Nabu Press, 2010].

Latour, B. (1987), *Science in Action: How to Follow Scientists and Engineers Through Society,* Milton Keynes: Open University Press.

- (1991), *Nous n'avons jamais été modernes,* Paris : Éditions La Découverte [en. tr. : *We Have Never Been Modern*, Cambridge (MA), Harvard University Press, 1993].
- (2005), *Reassembling the Social: An Introduction to Actor-Network-Theory,* Oxford: Oxford University Press.

Lave, J., Wenger, E. (1991), *Situated Learning: Legitimate Peripheral Participation*, Cambridge: Cambridge University Press.

Law, J. (1987), Technology and Heterogeneous Engineering: The Case of Portuguese Expansion, in W.E. Bijker, T.P. Hughes, and T.J. Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge (MA): MIT Press.

Le Breton, D. (1990), *Anthropologie du corps et modernité*, Paris: PUF.

- (2004) Genetic fundamentalism or the cult of the gene, *Body and Society*, 10(4), pp. 1-20.

Lewontin, R. (1993), *Biology as ideology: The doctrine of DNA*, New York: HarperCollins.

- (2002) *Gene, organismo e ambiente,* Bari, Laterza [en. ed.: *The triple helix. Gene, organism and environment*, Cambridge (MA): Harvard University Press, 2000].
- (2004), *Il sogno del genoma umano e altre illusioni della scienza*, Bari: Laterza [en. ed.: *It ain't necessarly so: The dream of human genome and other illusions*, New York: New York Review Books, 2001].

Lefebvre, H. (1974), *La production de l'espace*, Paris : Anthropos [en. ed.: *The Production of Space*, Hoboken : Wiley, 1991].

Leroi-Gourhan, A. (1964), *Le geste et la parole*, Paris : Albin Michel [en. ed. : *Gesture and Speech*, Cambridge (MA) : MIT Press, 1993].

Lessig. L. (2005), *Free Culture. The Nature and Future of Creativity,* New York Penguin Book.

Maasen, S. and Weingart, P. (2000), *Metaphors and the Dynamics of Knowledge,* London: Routledge.

Maestrutti, M. (2011), *Imaginaires des nanotechnologies. Mythes et fictions de l'infiniment petit,* Paris : Vuibert.

Marcuse, H. (1963), *One-Dimensional Man*, Boston : Beacon Press.

Marsonet, M. (2012), Il Gramsci revival ha le sue ragioni: ma non è il caso di stravolgerne il pensiero per farlo lib-lab: at http://www.legnostorto.com/index.php?option=com_content&task=view&id=34786&Itemid=29

Martinelli, A. (1998), *La modernizzazione*, Bari: Laterza.

Marx, K. (1959), *Economic and Philosophic Manuscripts of 1844*, Moscow : Progress Publishers.

- (1964), *Il capitale*. *Critica dell'economia politica*, Rome: Editori Riuniti [en.ed.: *The Capital. A Critique of Political Economy*, London: Penguin, 1990].

Maturana, H., Varela, F. (1980) *Autopoiesis and cognition*. *The realization of the living*, Boston: Reidel.

Mauss, M. (1923-1924), Essai sur le don. Forme et raison de l'échange dans les sociétés primitives, *l'Année Sociologique*, seconde série [en. ed. : *The Gift. Forms and Functions of Exchange in Archaic Societies,* London : Cohen and West, 1966].

  - (1936), Les techniques du corps, *Journal de Psychologie*, XXXII, 3-4, 15, pp.5-23. [en.tr.: Techniques of the body, *Economy and Society*, 2:1, 1973, pp. 70-88].

Mayr, E. (1961), Cause and effect in biology. *Science,*134, pp. 1501-1506.

Mead, G. H. (1934), *Mind, Self and Society*, Chicago: The University of Chicago Press.

Meneghelli, A. (2011), *Il risveglio dei sensi. Verso un'esperienza di gioco corporeo*, Milan, Unicopli.

Merlau-Ponty, M. (1945), *Phénoménologie de la perception,*Paris : Gallimard [en. tr. : Phenomenology of Perception, London : Routledge and KeganPaul, 1962].

Merton, R. K. (1949), *Social Theory and Social Structure*, New York: The Free Press.

Michaels, T. (1999). General public release for plant germplasm: A proposal, Version 1.1, 26 February. At http://horticulture.cfans.umn.edu/Who_sWho/Faculty/TomMichaels/GeneralPublicLicenseforGermplasm/

Monod, J. (1977), Le frontiere della biologia, in AA. VV. *La biologia molecolare. Storia e ricerca*, Rome: Newton Compton, pp. 33-47.

Monod, J., Jacob, F. (1961), General conclusions: Teleonomic mechanisms in cellular metabolism, growth and differentiation, *Cold spring harbor symposium on quantitative biology*, 26, pp. 306-329.

Moravec, H. (2000), *Robots, Re-Evolving Mind*, Carnegie Mellon: University Robotics Institute.

Morgavi, G. (2011), Robotica epigenetica ed implicazioni socio-psicologiche, in G. Nicolosi (ed.), *Robot. La macchina, il corpo, la società*, Florence : Ed.it.

Moricot, C. (1997), *Des avions et des hommes*, Lille : Presses Universitaires du Septentrion.

Moss, L. (2009), Detachment, Genomics and the Nature of Being Human, in M. Drenthen, J. Keulartz and J. Proctor (eds.) *New visions of nature*. *Complexity and authenticity*, Dordrecht: Springer.

Moss, L., Pavesich, V. (2011), Science, normativity and skill: Reviewing and renewing the anthropological basis of critical theory, in L. Moss and V. Pavesich *Philosophy and Social Criticism*, 37, 2, pp. 139-165.

Mumford, L. (1934), *Technics and civilization*, New York: Harcourt Brace and Co..

Negri, A. (2006), *Fabrique de porcelain*. *Pour une nouvelle grammaire du politique*, Paris : Stock [en. tr. : *The Porcelain Workshop. For a New Grammar of Politics,* Los Angeles (CA): Semiotext(e), 2008].

Neumann, O., Prinz, W. (eds.) (2011), *Relationships Between Berception and Action. Current Approaches*, Berlin: Springer-Verlag.

Nicolosi, G. (2006), Biotechnologies, alimentary fears and the orthorexic society, *Tailoring Biotechnologies,* 2, 3, pp. 37-56.

Noble, D. (1993), Present Tense Technology, *Democracy*, 3, 2, pp. 8-24.

Noë, A. (2005), *Action in Perception*, Cambridge (MA): MIT Press.

- (2010), *Out of Our Heads. Why You Are Not Your Brain, and Other Lessons from the Biology of Consciousness*, New York: Hill and Wang.

Odling-Smee, F. J. (1988), Niche constructing phenotypes, in H. Plotkin (ed.) *The Role of Behavior in Evolution*, Cambridge (MA): MIT Press, pp. 73–132.

- (2002), Niche construction, evolution and culture, in T. Ingold (ed.) *Companion encyclopedia of anthropology: Humanity, culture and social life*, London: Routledge pp. 162-196.

Odling-Smee, F.J., Laland, K.N. and Feldman, M.W. (2003), *Niche Construction: The Neglected Process in Evolution*, Princeton: Princeton University Press.

Ogburn, W. F. (1923), *Social Change: With Respect to Cultural and Original Nature*, New York: B. W. Huebsch Inc.

Orwell, G. (1946), Politics and the English Language, *Horizon,* April.

Ostrom, E. (1990), *Governing the commons. The evolution of institution for collective action,* Cambridge: Cambridge University Press.

Oyama, S. (1998), *The evolution's eye. A systems view of the biology-culture divide*, Durham: Duke University Press.

Oyama, S., Griffiths, P. E. and Gray R. D. (eds.) (2001), *Cycles of contingency. Developmental systems and evolution*, Boston: MIT Press.

Paccagnella, L. (2004*), Sociologia della comunicazione,* Bologna: Il Mulino.

- (2010), *Open access. Conoscenza aperta e società dell'informazione,* Bologna: Il Mulino.

Peirce, C. S. (1932-58), *Collected Papers*, C. Hartshorne and P. Weiss (eds.), Cambridge 8MA): Harvaard University Press.

Perriault, J. (1989), *La logique de l'usage*, Paris : Flammarion.

Pievani, T. (2004), Exaptation: la biologia dell'imprevedibile. Un approccio costruttivista all'idea di 'adattamento', in P. Barbetta, M. Capararo, T. Pievani, *Sotto il velo della normalità*, Roma: Meltemi, pp. 13-142.

Pigliucci, M. (2001), *Phenotypic plasticity*, Baltimore: JHU Press.

Pinch, T., Bijker, W. (1987) ,The Social Construction of Facts and Artefacts, in W. Bijker, T. Hughes and T. Pinch (eds.), *The Social Construction of Technological Systems*, Cambridge: MIT Press.

Polanyi, K. (1944), *The Great Transformation*. *The political and Economic Origins of Our Time*, Boston: Beacon Press.

Polanyi, M. (1958), *Personal Knowledge: Towards a Post-Critical Philosophy*, London: Routledge and Paul Kegan.

Postman, N. (1993), *Technopoly: The Surrender of Culture to Technology*, New York: Vintage Books.

Rai, A., Boyle, J. (2007), Synthetic biology: Caught between property rights, the public domain, and the commons, *PloS Biology,* 5:3 e58. doi:10.1371/journal.pbio.0050058.

Raymond, E. (1999), *The Cathedral and the Bazaar*, Sebastopol (CA): O'Reilly Media,1999].

Rizzolatti, G., Sinigaglia, C. (2006), *So quel che fai*, Milan: Raffaello Cortina Editore.

Rose, N. (1996), *Inventing our selves. Psychology, power and personhood,* Cambridge: Cambridge University Press.

Ruivenkamp, G. (2005), Tailor-made biotechnologies: Between biopower and subpolitics. *Tailoring Biotechnologies,* 11, pp. 11-33.

- (2008) *Biotechnology in development: Experiences from the south*, Wageningen: Wageningen Academic Publishers.
- (2009), Scienza, lavoro immateriale e politica: Appunti per una 'terza via' biotecnologica., in M. Negro, F. Ciaramelli and G. Nicolosi (eds.), *L' esperienza del corpo nell' era delle biotecnologie,* Enna: Città Aperta Edizioni, pp. 145-182.

Ruivenkamp, G., Hisano S. and Jongerden J. (eds.) (2008), *Reconstructing Biotechnologies: Critical Social Analyses*, Wageningen: Wageningen Academic publishers.

Rytina, J. H., Loomis, C. P. (1970) Marxist Dialectic and Pragmatism: Power as Knowledge, *American Sociological Review*, Vol. 35, No. 2, pp. 308-318.

Sclove, R. (1995), *Democracy and technology,* New York: Guilford Press.

- (2012), *Reinventing technology assessment for the 21st century,* Washington: WWICS.

Sennett, R. (2009), *The Craftsman,* New Haven: Yale University Press.

Severino, E. (1972), *Essenza del nichilismo*, Milan: Adelphi.

Shalin, D. N. (1992), Critical Theory and the Pragmatist Challenge, *American Journal of Sociology*, Vol. 98, n° 2, pp. 237-279.

Shiva, V. (2004), L'industria biotecnologica si basa su fondamenta di menzogne e illegalità, in C. Silici, *OGM. Le verità sconosciute di una strategia di conquista*, Rome: Editori Riuniti.

Shusterman, R. (1999), *Bourdieu: A Critical Reader*, Oxford: Blackwell Publishers.

Sigaut, F. (1993), How Can We Analyse and Describe Technical Actions?, in A. Berthelet and J. Chavaillon, *The Use of Tools by Human and Non-Human Primates*, Oxford: Clarendona Press, pp. 381-400.

- (1994), Technology, in T. Ingold (ed.) *Companion encyclopedia of anthropology: Humanity, culture and social life*, London: Routledge, pp. 420-459.
- (2007), Les outils et le corps, *Communications,* 81, pp. 9-30.

Sini, C. (1993), *Discorso sul metodo di Cartesio*, Milano: Mondadori.

Smith, C. (2009), A Critical Pragmatism: Marcuse, Adorno and Peirce on the Artificial Stagnation of Individual and Social Development in Advanced Industrial Societies, *Kritike*, Vol. 3, n° 2, pp. 30-52.

Stallman, R. M. (2002), *Free software, free society,* Boston (MA): Gnu Press.

Stelarc (1994), Da strategie psicologiche a cyber strategie: prostetica, robotica ed esistenza remota, in P. L. Capucci, *Il corpo tecnologico. L'influenza delle tecnologie sul corpo e sulle sue facoltà,* Bologna: Baskerville, pp. 61-76.

Sterelny, K. (2001), Niche construction, developmental systems and the extended replicator, in S. Oyama, P. E. Griffiths and R. D. Gray (eds.) *Cycles of Contingency. Developmental Systems and Evolution*, Boston: MIT Press, pp. 333-50.

Stiegler, B. (1998), *Technics and time, I.* Stanford (CA): Stanford University Press.

Strydom, P. (2011), *Contemporary Critical Theory and Methodology*, Abingdon: Routledge.

Suarez-Villa, L. (2001), The rise of technocapitalism, *Science Studies*, 14, 2, pp. 4-20.

Suchman, L. A. (2007), *Human-Machine Reconfigurations*, Cambridge: Cambridge University Press.

Van Dijk, J. (1998), *Imagenation. Popular Images of Genetics*, New York: New York University Press.

Van der Ploeg, J. D., Long, A. (eds.) (1994), *Born from within. Practice and perspectives of endogenous rural development,* Assen: Van Gorcum.

Varela, F., Thompson, E. and Rosh, E. (1991), *The Embodied Mind*, Cambridge (MA): MIT Press.

Vidal, D. (2007), Anthropomorphism or sub-anthropomorphism? An anthropological approach to gods and robots, *Journal of the Royal Anthropological Institute (N.S.),* 13, pp. 917-933.

Virilio, P. (1988), *La machine de vision*, Paris : Editions Galilée [en.tr.: The Vision Machine, Bloomington : Indiana University Press, 1994].

Von Hippel, E. (2005), *Democratizing innovation*, Cambridge (MA): MIT Press.

Waddington, C. H. (1953), Genetic assimilation of an acquired character, *Evolution*, 7, pp. 118-126.

- (1959), Evolutionary systems – animal and human, *Nature*, 183, pp. 1634-8.

Warwick, K. (2004), I, Cyborg, Champaign: University of Illinois Press.

Westbrook, R. B. (1991), *John Dewey and American Democracy*, Ithaca: Cornell University Press.

West-Eberhard, M. J. (2003), *Developmental Plasticity*, New York: Oxford University Press.

- (2005a), Phenotypic accommodation: adaptive innovation due to developmental plasticity, *Journal of Experimental Zoology (mol dev evol),* 304b, pp. 610–18.
- (2005b), Developmental plasticity and the origin of species differences, *PNAS,* 102, suppl. 1, pp. 6543-6549.

White, S. K. (1995), *The Cambridge Companion to Habermas*, Cambridge: Cambridge University Press.

Winner, L. (1995), Citizen virtues in a technological order, in A. Feenberg and A. Hannay (eds.), *Technology and the politics of knowledge,* Bloomington: Indiana University Press, pp. 65-84.

Woolgar, S. (1991), Configuring the User: The Case of Usability Trials, in J. Law (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*, London: Routlledge.

SUMMARY

In the general understanding, and also in scientific practice, technology and society are viewed as two distinct entities. Related to this view is the assumption that technology and human experience are quite different and unconnected and also the idea that modernity has uprooted, de-contextualized and disembodied technical rationality. Taking a contrary approach, this study represents a theoretical exploration aimed at showing that in the domain of technological development, there are significant margins for maneuver in which to recuperate and valorize human and social action.

As a work of theoretical sociology or social epistemology, this thesis approaches its subject from the theoretical background of the philosophy and sociology of technique. The historical and conventional assumptions of this theoretical background, it is argued, have been and continue to be characterized by a hegemonically defined essentialist paradigm. This paradigm has been fiercely counteracted by two opposed approaches, *critical theory* and *pragmatism*. The present work combines these approaches, usually considered mutually incompatible, for the development of a new theoretical gaze or perspective. The aim has been to engage in a theoretical research oriented to a new *philosophy of praxis* in order to instigate a critical and constructivist approach to technology. The main result expected of this work is the provision of a problematized and multifaceted semantic map leading to a multidimensional conceptual re-integration of skilled experience in human technical action.

Chapter 1 comprises the methodological presentation of this research. It introduces the problem statement and the research questions, the thesis structure and the rhizomatic method of this work. It is also explained the conceptual process leading to the selection of the unit observation (skills).

Chapter 2 explicates the theoretical background to the research. The *first section* discusses the hegemonic determinist paradigm (an essentialist inclination) within the field of the philosophy of technique that has sought to demonstrate how *the passage from technique to technology* (from ancient to modern society) has brought about the understanding of *the separation of the role of experience and human acting* (hence of perception, action,

intentionality and praxis). In its idealized form, this underwrites the narrow interests of elites, while the darker version presents dystopian visions of alienation and apocalypse. At the root of this paradigm is an analysis of modern technology as having i) disembedded and detached technique from the social and cultural fabric that had safeguarded it for centuries, and thus ii) rendered it an autonomous *corpus*, a neutral and independent ensemble, linked to 'inner' logics and dynamics and answering exclusively to linear principles of efficiency, effectiveness, functionality and rationality.

The *second section* briefly overviews the philosophy of praxis, with the intent of showing that this may offer a real alternative to the determinism of the essentialist paradigm. It is suggested that it was precisely the sidelined concept of praxis that Marx's thinking had set center stage in his critical analysis of technique, and that this led to a logical paradox in the history of Western thought which continues to heavily condition philosophy: technique, the essence of man, expands in modernity out of all proportion, to end up by negating man in his essence. The *third section* explores how the paradox has transversally conditioned not only conservative currents of thought but also progressive ones, with particular reference to the Frankfurt School, which has been very influential in the social critical thinking of the Left. This influence, it is suggested, has damaged the revolutionary potential of the philosophy of praxis that the Frankfurt School, as a neo-Marxist tendency, should have developed and diffused.

The *fourth section* discusses how Andrew Feenberg's thinking has brought *a* philosophical vision to the field of the analysis of technique that is able to rehabilitate Marx's concept of praxis and thereby introduces a possible way out of the blind alley of needing to choose between the two unsatisfactory visions: the determinism of the philosophy of essentialist technique or the insufficiently critical potential of constructivism. Constructivism recognizes the fundamental role played by society in determining the very nature of technique but has a limited vision of social conflict mediated by science, technology and technical expertise. Sagaciously combining the anti-essentialism of constructivism with the analyses of socio-political dynamics linked to power relationships and class conflict produced by the Frankfurt School, Feenberg has managed to revalorize the role of experience and praxis in technical action. This is a revaluation, moreover, oriented to supporting the possibility of changing technological development in the direction of a *democratic rationalization* and a greater

participation from below (bottom up). Finally, the fifth section introduces the new theoretical perspective of a critical pragmatism oriented to stimulating a new materialist philosophical orientation that emerges from a fecund (albeit difficult) encounter between the anti-essentialist current of critical theory and pragmatist philosophy.

Chapter 3 investigates the possibilities of a *bio-anthropological foundation* that can explain and justify the importance of experience in human culture and presents an overview of a contemporary epistemological paradigm that seems to be able to represent such a foundation in the life sciences. The paradigm suggested is that of *epigenetics and its conception of the organism*, regarded as scientifically supporting a socio-anthropological idea of man as a real *being-in-the-world*, an intentional body that lives out a relationship of reciprocity with the surrounding environment (physical and social).

The last three decennia have seen an intensive debate in science and wider society on the development and impact of genetics and genomics. This debate had important scientific, philosophical, economic and symbolic implications. The general assumption of the third chapter is that in spite of the wide range of actors and institutions (scientists, politicians, churches, bio-ethicists, etc.) animating this discussion with a variety of (often opposing) views, the debate in itself takes place within a hegemonic scientific and cultural framework built upon specific conceptual interpretations of life that demands the development of a critical reflection. This chapter reflects both on the basic epistemological pillars of this hegemonic paradigm and on the emergence of a new scientific and epistemological turn that leaves the gene-centric paradigm in serious crisis.

Chapter 4 presents a reflection on the advent of modern technology, focusing on a discussion of whether this has really ended the relationship between bodily experience and material reality, or whether, in fact, an innovative and skilled handicraft experience of the world still exists in the context of contemporary technological developments. This chapter thus represents a *socio-anthropological approach* to the subject at hand, with the approach being informed by two different theoretical contributions or perspectives.

Supported by of the work of British anthropologist Tim Ingold, the first perspective highlights the 'ecological' principle according to which it is never a single organ (quintessentially, the

hand) that represents the privileged locus of technical skills, insofar as these are generally nested within a 'technicity', namely, in the particular alignment (tuning) between corporeity, the situational context and the materials and tools used. Supported by theoretical contributions of a pragmatist and phenomenological inclination, the second perspective here seeks to illustrate how the reduction of the manual dimension of work (whose demise is seen, in fact, as highly improbable) does not necessarily imply a complete retreat of the innovative nature and singularity of action preserved in human experience. For this reason, the development of mechanical and electronic technology – including, now, the digital – has not, in fact, brought about many of the pessimistic prophecies that over the years have foretold the end of creative handicraft skills tied to the expert use of tools.

The line of reasoning developed aims to highlight that, if technicity is not defined in terms of a single organ representing the privileged locus of technical skills (since these are, in fact, linked to the tuning of our body with the surrounding environment), then the advent of modern technologies cannot do away with such a locus in absolute terms by transferring it to a technological design encapsulated in a set of rules and defined algorithms. Indeed, the user is still and will always be a body operating within a context. Moreover, as is stressed using insights from Richard Sennett, the advent of new (digital) technologies is actually opening up interesting potential margins of recovering a dynamic feedback between operator, tool and environment (the physical and social). And while dextrous (finger) manipulations may characterize this at present, it is surely no longer primarily centered on the manual and corporeal dimension of the gesture (which indeed can be re-valorized) so much as on the intellectual and socio-relational dimension of design. The consequence of this argument is that today there are (at least potentially) relevant theoretical and practical margins around the hegemonic center within which to stimulate a recovery of the value of experienced and skilful technical action.

Chapter 5 presents a concrete case through which it is possible to perceive and develop this room for maneuver to recover and give value to experience and social skills in modern technical action as proposed in the argument of the previous chapters. The relevant literature for this chapter is anchored more to a *socio-political analysis*, primarily because the rediscovery of skills and experience within technological innovation processes inevitably oblige us to reflect on the issue of *participation*. Thus, the question is addressed of whether

these practices give voice to the possibility of a better *democratization of technology*. In particular, focus is placed on a specific technological practice, that of open source, as potentially paving the way to a new participatory development model of technology, one that is more democratic and open to human action. This model is able to establish a participatory approach that makes the hegemonic 'technical code' discussed by Andrew Feenberg an open entity in which it is possible to realize creative processes, including those of re-appropriation designed to literally re-invent used technologies.

This chapter attempts to apply the participatory re-appropriation principles to the emblematic and controversial case of *biotechnology development*. In particular, it is suggested that there is room for maneuver in order to conceive of and also materially produce *re-skilling practices*. The argument made is that it is possible to develop practices aimed at *the re-encapsulation of technology within social relations,* practices aimed at an *empowerment* of communities and the participatory and shared rehabilitation of technological production *ex-ante* and with the aim of supporting a more *democratic endogenous development* that has the potential to more closely *bind technological innovation to the goals of social sustainability* and reduction of inequalities.

Chapter 6 concludes by reviewing the study structure and key issues and presenting the main conceptual results as an original semantic map. The particular value of this map lies in its visual presentation of semantic links and connections among the issues developed. As a second main aim, this chapter also engages in a general discussion aimed at sketching out new questions representing proposals for future lines of research. This overview critically defines the outline of a theory of democratization of technology related to the advent of open source. Specifically, it looks forward to the possibilities for re-skilling practices as a new form of democratic participation based on the social sharing of technology. These questions are related to anthropological, sociological, philosophical, political and ethical domains of reflection. Issues discussed include reciprocity, technical creativity, self-exploitation, technological elitism, do-ocracy, mutualism, open-source unionism and ethical-governance reconfiguration. Finally, a brief synopsis is provided linking all these possible research directions to the democratic implications of open source re-skilling practices.

SAMENVATTING

Technologie en samenleving worden vaak als twee afzonderlijke entiteiten gezien. Gerelateerd aan deze opvatting is de vooronderstelling dat technologie ontkoppeld is van de menselijke ervaring en dat de moderniteit ook gekenmerkt wordt door een technische rationaliteit die op zichzelf staat. Ondanks de dominante positie van deze perceptie van technologie in wetenschappelijke en algemene publieke kringen, wordt in deze studie een tegenovergestelde theoretisch verkenning uitgevoerd. Dit onderzoek is erop gericht om aan te tonen dat de mens juist wel een aanzienlijke manoeuvreerruimte heeft op het gebied van technologische ontwikkeling en dat de menselijke ervaring en het sociale handelen wel in het centrum van de belangstelling kan komen te staan en opnieuw gewaardeerd kunnen worden.

Als een theoretisch sociologisch of sociaal epistemologisch werk worden technologie en samenleving in dit proefschrift benaderd vanuit een techniek filosofische en techniek sociologische achtergrond. De historische en conventionele vooronderstellingen van dit theoretische referentiekader worden gekenmerkt – zo wordt betoogd – door een essentialistisch paradigma van technologieontwikkeling dat een hegemoniale positie heeft verworven en bepalend is voor ons kijken naar techniek in de huidige tijd. Toch zijn er twee filosofische stromingen geweest – de *kritische theorie en het pragmatisme* - die zich sterk hebben afgezet tegen de hegemoniale positie van het essentialistische technologische paradigma. Hoewel deze twee benaderingen vaak als onderling tegenstrijdig en incompatibel zijn beschouwd, wordt in dit proefschrift geprobeerd deze twee benaderingen samen te brengen voor de ontwikkeling van een nieuw theoretisch perspectief; een nieuwe lens van waaruit naar technologieontwikkeling kan worden gekeken. Het proefschrift beoogt een theoretisch onderzoek uit te voeren dat erop gericht is een bijdrage te leveren aan de ontwikkeling van een nieuwe *filosofie van de praxis* om van daaruit een kritisch en constructivistische technologie benadering te gaan ontwikkelen. Het belangrijkste resultaat dat van deze studie verwacht kan worden is de schets van een veelzijdig semantische kaart die de hegemoniale positie van het essentialistische paradigma problematiseert en een aanzet geeft tot een multi-dimensionele en nieuwe integratie van de menselijke ervaring in het technisch handelen.

Hoofdstuk 1 presenteert de methodologie van dit onderzoek en bespreekt de probleemstelling, onderzoeksvragen, de opbouw en de rhizomatische onderzoeksmethode van het proefschrift. Bovendien wordt het conceptuele proces uitgelegd dat leidt tot de selectie van "skills" als observatie-eenheid.

Hoofdstuk 2 expliciteert de theoretische achtergrond van het onderzoek. Het *eerste deel* bespreekt het deterministische paradigma (met de essentialistische nadruk) en de hegemoniale positie in de techniekfilosofie. Daarbij wordt aangetoond hoe de *overgang van techniek (*in de klassiek oude samenleving) *naar technologie* (in de moderne samenleving) heeft geleid tot de aanname dat technologieontwikkeling is *losgekoppeld van de menselijk ervaring en het menselijk handelen* (en dus van de waarneming, handeling, intentionaliteit en praktijk). In zijn geïdealiseerde vorm representeert deze ontkoppelde technologieontwikkeling de beperkte belangen van elites, terwijl de ontkoppelde technologieontwikkeling bezien vanuit een pessimistische invalshoek een weergave vormt van de dystopieën van vervreemding en vernietiging van de wereld (Apocalyps). Aan de basis van dit paradigma staat een analyse van de moderne technologie als voortkomend uit i) de techniek die ontkoppeld en losgemaakt is van de sociale en culturele context waaraan zij eeuwenlang gerelateerd was, waardoor ii) de techniek (nu als technologie) een autonoom corpus is geworden; een neutraal en onafhankelijk geheel dat uitsluitend gerelateerd is aan de 'intrinsieke' logica en dynamiek van de technologieontwikkeling en nog uitsluitend reageert op de lineaire principes van efficiëntie, effectiviteit, functionaliteit en rationaliteit.

Het *tweede deel* van Hoofdstuk 2 geeft een kort overzicht van de filosofie van de praxis om aan te tonen dat deze filosofie een echt alternatief kan bieden voor het determinisme van het essentialistische paradigma. Er wordt betoogd dat juist door het negeren van het concept van praxis - dat in Marx denken centraal staat in zijn analyse van techniek - er een logische paradox ontstond in de geschiedenis van het westerse denken die de techniekfilosofie sterk is blijven conditioneren. Een paradox waarin techniek enerzijds het wezenlijke van de menselijke conditie vertegenwoordigt maar anderzijds zich zodanig in de moderniteit heeft uitgebreid dat de techniek ernaar neigt de mens in zijn existentiële essentie te ontkennen.
Het *derde deel* van Hoofdstuk 2 onderzoekt hoe deze paradox niet alleen invloed heeft gehad op conservatieve denkstromingen, maar ook op de progressieve denkstromingen over technologie - in het bijzonder op het denken van de "Frankfurter Schule" – dat grote invloed

heeft gehad op het linkse maatschappijkritisch denken. De invloed van deze paradox – zo wordt betoogd - heeft het revolutionaire potentieel van de praxis filosofie, die de Frankfurter Schule als neo-marxistische stroming juist ontwikkeld zou moeten hebben, aangetast.
Het *vierde deel* bespreekt hoe Andrew Feenberg's denken heeft geleid tot een filosofische visie op de techniek die in staat is om Marx praxis concept te rehabiliteren en een mogelijke uitweg biedt uit de impasse om te moeten kiezen tussen twee onbevredigende visies op technologieontwikkeling: het determinisme van de essentialistische techniekfilosofie en het onvoldoende kritisch potentieel van het constructivisme. Het constructivisme erkent dat de samenleving een fundamentele rol speelt in het bepalen van het wezen van de techniek maar heeft een beperkte visie op maatschappelijk conflicten die bemiddeld worden door wetenschap, technologie en technische expertise. Door op een scherpzinnige wijze het anti-essentialisme van het constructivisme te combineren met de sociaal-politieke analyses van de dynamiek van machtsverhoudingen en het klassenconflict door de Frankfurter Schule, is Feenberg erin geslaagd de rol van de menselijke ervaring en van de praxis in het technisch handelen te rehabiliteren. Deze rehabilitatie is gericht op de ondersteuning van veranderende technologische ontwikkelingen in de richting van een *democratische rationalisering en een grotere participatie van onderaf* (bottom-up).

Tot slot introduceert het *vijfde deel* van Hoofdstuk 2 het nieuwe theoretisch perspectief van het *kritisch pragmatisme* dat erop gericht is een nieuw materialistische filosofische oriëntatie te stimuleren die voortkomt uit een vruchtbaar (zij het moeilijke) ontmoeting tussen de anti-essentialistische stroming van kritische theorie en de pragmatische filosofie.

Hoofdstuk 3 onderzoekt de mogelijkheden voor een *bio-antropologische* fundering die het belang van ervaring in de menselijke cultuur kunnen verklaren en rechtvaardigen, en geeft een overzicht van het hedendaagse epistemologische paradigma dat in staat lijkt te zijn om een dergelijke bio-antropologische fundering in de levenswetenschappen te vestigen. Het voorgestelde moderne epistemologische paradigma is dat van de *epigenetica en haar conceptualisering van het organisme*; een conceptualisering dat het sociaal-antropologisch idee van de mens als een "*zijn-in-de-wereld*" wetenschappelijk ondersteunt; als een doelbewust ageren op haar omringende (fysieke en sociale) omgeving vanuit een relatie van wederkerigheid.

In de afgelopen drie decennia vond er in de verschillende delen van de wereld een intensief debat plaats in de wetenschap en samenleving omtrent de ontwikkeling en impact van genetica en genomics. Dit debat had belangrijke wetenschappelijke, filosofische, economische en symbolische implicaties. De algemene veronderstelling van het derde hoofdstuk is dat dit debat - ondanks de aanwezigheid van vele actoren en instellingen (wetenschappers, politici, kerken, bio-ethici, etc.) die vanuit verschillende en (vaak tegengestelde) standpunten aan dit debat deelnamen – toch plaatsvond binnen één hegemoniaal wetenschappelijke en cultureel kader dat zich baseerde op specifieke conceptuele interpretaties van het leven. Interpretaties die een kritisch reflectie noodzakelijk maken. In dit hoofdstuk vindt deze kritisch reflectie plaats op de basale epistemologische pijlers van dit hegemoniale gen-centrische paradigma én wordt gewezen op de opkomst van een nieuwe wetenschappelijke en epistemologische verandering die het gen-centrische paradigma in een ernstige crisis brengt.

Hoofdstuk 4 reflecteert op de opkomst van moderne technologie en richt zich op de vraag óf de moderne technologie echt de relatie tussen lichamelijke ervaring en materiële werkelijkheid beëindigd heeft óf dat er toch nog steeds een innovatieve en deskundige ambachtelijke ervaring bestaat in de context van de hedendaagse technologische ontwikkelingen. Dit hoofdstuk vertegenwoordigt aldus een *sociaal-antropologische benadering* ten opzichte van het in dit proefschrift behandelde thema en doet dit door twee verschillende theoretische bijdragen of perspectieven uit te werken.

Allereerst wordt het perspectief van het "*ecologisch beginsel*" toegelicht zoals dat door het werk van de Britse antropoloog Tim Ingold wordt ondersteund. Volgens het "ecologische" beginsel is het nooit één enkel orgaan (zoals de hand) dat de bevoorrechte plaats van technische vaardigheden vertegenwoordigt, daar deze vaardigheden eerder in algemene zin zijn ingebed in "techniciteit", namelijk in de specifieke onderlinge afstemming van lichamelijkheid, situationele context, materialen en gebruikte gereedschappen. Gesteund door theoretische bijdragen vanuit een pragmatische en fenomenologische invalshoek wordt een tweede perspectief uitgewerkt. Daarin wordt aangetoond dat een vermindering van de manuele dimensies in het werk (waarvan hun afschaffing als hoogst onwaarschijnlijk wordt gezien) niet noodzakelijk een volledige terugtrekking impliceert van de innovatieve eigenheid en singulariteit van de technische handeling die bewaard blijft in de menselijke ervaring. Vandaar dat de ontwikkeling van mechanische, elektronische – inclusief recentelijk - de

digitale technologieën niet heeft geleid tot een beëindiging van creatieve ambachtelijke vaardigheden, zoals dat in vele pessimistische profetieën is voorspeld.

De redenering die hier ontwikkeld wordt beoogt duidelijk te maken dat als "techniciteit" niet meer geassocieerd wordt met één orgaan (bijv. de hand) - als zijnde de bevoorrechte plaats van waar de technische vaardigheden zich voltrekt (omdat deze vaardigheden juist verbonden zijn met de afstemming van het gehele lichaam op de omringende omgeving) - dan kan ook de opkomst van moderne technologieën deze wederkerige relatie van het lichaam met de (nieuwe) omgeving niet negeren. Ook wordt het onmogelijk om die technische vaardigheden dan uitsluitend te verplaatsen naar een technologisch ontwerp met een set van regels en gedefinieerde algoritmen. De gebruiker van nieuwe technologieën is en zal altijd een fysieke eenheid (a body) zijn die vanuit een context opereert. Bovendien wordt met behulp van inzichten van Richard Sennett benadrukt dat door de opkomst van nieuwe (digitale) technieken een opening kan ontstaan voor interessante potentiële marges van waaruit een dynamische koppeling tussen *operator*, gereedschap en fysiek en sociale omgeving hersteld kan worden. Een koppeling die in het huidige digitale tijdperk gekenmerkt wordt door vingeroefeningen op het toetsenbord maar waarbij die koppeling toch niet primair verwijst naar deze manuele en lichamelijke dimensies (hoewel die wel opgewaardeerd kunnen worden) maar eerder naar de intellectuele en sociaal-relationele dimensies van de handeling. De consequentie van dit betoog is dat er momenteel (minstens potentieel) relevante theoretische en praktische marges zijn rondom het hegemoniale technologisch ontwerp van waaruit experimenteel en ambachtelijk technisch handelen opnieuw bedacht en geïmplementeerd kan worden.

Hoofdstuk 5 presenteert een concrete casus, van waaruit het mogelijk is om deze manoeuvreerruimte waar te nemen en te ontwikkelen, en het belang te herkennen van de menselijke ervaring en van sociale vaardigheden in het moderne technisch handelen, zoals betoogd in de voorafgaande hoofdstukken. De relevante literatuur voor dit hoofdstuk verwijst meer naar een *sociaal-politieke analyse*, omdat de herontdekking van het belang van vaardigheden en ervaringen binnen technologische innovatieprocessen ons onvermijdelijk dwingen na te denken over *participatie* en de vraag te stellen of deze vaardigheden en praktijken uiting geven aan de mogelijkheid *technologieontwikkelingen te democratiseren*. In het bijzonder wordt aandacht besteed aan een bepaalde technologische praktijk, die van *open*

source, en wordt nagegaan of die praktijk in potentie de mogelijkheid biedt de weg vrij te maken naar een nieuw participatief ontwikkelingsmodel van technologie dat democratischer is en opener staat voor het menselijk handelen. Het hoofdstuk betoogt dat dit *open source* model in staat is een participatieve benadering te hanteren waardoor de hegemoniale 'technische code', zoals besproken door Andrew Feenberg, veranderd kan worden in een open code die het mogelijk maakt creatieve processen te realiseren, inclusief een maatschappelijke toe-eigening van het ontwerpproces en het opnieuw uitvinden van technologieën die al in gebruik zijn.

Dit hoofdstuk probeert de principes van de participatieve toe-eigening toe te passen op de emblematische en controversiële casus van de *biotechnologie ontwikkeling*. In het bijzonder wordt erop gewezen dat er manoeuvreerruimte bestaat niet alleen om zich ambachtelijke praktijken te kunnen voorstellen maar ook om deze daadwerkelijk tot stand te brengen. Betoogd wordt dat het mogelijk is om praktijken te ontwikkelen die erop gericht zijn technologie te re-contextualiseren en vanuit specifieke sociale relaties te ontwikkelen. Het betreft praktijken die gericht zijn op de “empowerment” van gemeenschappen en op een participatief en gedeeld herstel van een ex-ante technologische productie, i.e. gericht op het ondersteunen van een democratischer en endogener ontwikkeling die in potentie het vermogen heeft om technologische innovatie te koppelen aan doelstellingen van sociale duurzaamheid en reductie van ongelijkheden.

Hoofdstuk 6 sluit het proefschrift af door de opbouw en belangrijkste thema’s van het proefschrift weer te geven en de conceptuele resultaten samen te vatten in een semantisch kaart. De toegevoegde waarde van deze kaart ligt in haar visuele presentatie van de semantische verbanden tussen alle in het proefschrift ontwikkelde thema’s. Ten tweede beoogt het hoofdstuk ook de relatie van dit proefschrift te schetsen met de algemene discussie over democratisering van technologieontwikkeling, gerelateerd aan de opkomst van open source en formuleert daarover vragen die voorstellen bevatten voor toekomstige mogelijke onderzoekstrajecten. Het richt zich daarbij op mogelijkheden om ambachtelijke vaardigheden als nieuwe democratische vormen van participatieve praktijken in te zetten in de ontwikkeling van technologieën die vanuit een gemeenschapsperspectief worden ingezet. Deze vragen hebben betrekking op en reflecteren over antropologische, sociologische, filosofische, politieke en ethische onderwerpen zoals reciprociteit, technische creativiteit, zelf-exploitatie,

technologisch elitarisme, doe-ocratie, mutualisme, open-source syndicalisme, en reconfiguratie van ethisch bestuur. Tenslotte worden al deze mogelijke onderzoeksrichtingen over de democratische implicaties van nieuwe ambachtelijke vaardigheden in open source praktijken samengevat in een tabel waarmee het proefschrift wordt afgesloten.