

**towards an interdisciplinary  
anthropology? the  
transformative  
epistemologies of bergson,  
bachelard, and simondon**

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A common thread that runs through the philosophies of Bergson, Bachelard and Simondon is that science is considered as a human, essentially technical practice that transforms our way to know and to act. Applying scientific principles and/or material tools transforms the world we live in and the way we understand the world and ourselves. Together with Bergson, Bachelard and Simondon I wish to explore *how* this act of transformation can be grasped. Each philosopher stresses different aspects of this epistemic act and how it relates the subject to the world. They aim not merely at an understanding of the already existing scientific structures, but rather at the historical transformations of concepts and categories, as well as the epistemic act of the subject itself.

Their epistemological models have therefore to provide the means to (1) access the transformations that occur in being as an object, (2) to grasp the epistemic act itself as a transformation of the human mind and (3) to conceive of the epistemic act as a technique that transforms reality. These three epistemological goals presuppose an ontology where being is in constant change and the epistemic subject has *access to* and *participates in* the transformative character of being. Otherwise transformation can neither be a phenomenon that can be perceived as an object of knowledge nor an experience of the epistemic subject that grasps itself in the act of knowledge.

The transformative epistemologies of Bergson, Bachelard and Simondon are thus based upon an ontology that allows for novelty, change and transformation. Reality is—according to them—constantly transforming itself. It seems, however, as if this implies a *petitio principii*: the transformative character of being is presupposed, while the epistemologies of Bergson, Bachelard and Simondon simultaneously wish to thematize ‘transformation.’ Change, transformation, and novelty appear to be properties of being that are shared by the human, epistemic subject. Thus, the question occurs, whether the epistemic subject can address and thematize transformations without begging the question. Or, to put it differently: why is the epistemic act to grasp transformation necessary at all, if a principle of being is transformation? Why do we not immediately grasp the first principles of being and understanding?<sup>1</sup>

Although it is neither unusual that epistemology is asking for its first principles, nor surprising that epistemology is linked with ontology, Bergson, Bachelard, and Simondon provide an interesting rendition of this classical problem: they transform the classical Aristotelian question “what is a being?” into the question “what does a being do?” They are not only interested in the structures that the sciences create and what can be known within this structures (e.g. what is a substance?), but they develop—despite their different approaches—epistemologies that focus on science and knowledge as practices of transformation (e.g. how does a substance operate?). This shift to focus on operations, rather than on structures has ontological, epistemological and anthropological consequences, which I wish to explore through following three major arguments:

1. First of all, human practices are technical practices. The human subject applies concepts in order to understand itself, life, and the universe. The understanding of concepts such as “substance,” “matter,” or “energy” changes over the course of time, according to the social milieu, and according to the method one applies to fathom the phenomena. Science is thus a human practice—a technique—that applies, creates and modifies these concepts. Therefore, Bergson, Bachelard and Simondon conceive of concepts as intellectual tools. But, the tool-use is interpreted differently by each of the three philosophers. Bergson defines the human being as *homo faber*. The use of intellectual tools reduces the mobile reality to static elements. Concepts can only fathom inadequately what reality has to offer. Accordingly, scientific concepts are devoid of the dynamic aspects of reality. For Bachelard on the other hand, scientific concepts are

the starting point of realization processes. Scientific concepts, theories and techniques are necessary to realize phenomena: the scientific process creates phenomena that could otherwise not be experienced by the epistemic subject (e.g. the wave-particle-dualism). This *phénoménotechnique* is an essential part of scientific work. While for Bergson science deforms reality, for Bachelard, science creates new realities with its conceptual tools and allows to mobilize philosophical concepts. Therefore, the *homo faber* does not adequately represent the new scientific spirit. The value of tools shifts again when cybernetics enters the scene. According to Simondon, cybernetics realizes an operational technology in relating one science to another. Thus, the tools are no longer used to realize phenomena belonging to a singular science, but the toolbox is opened for other sciences. If a problem arises in a specific science but cannot be solved within its conceptual framework, other sciences and their *phénoménotechnique* might be helpful to pose the questions differently and/or to answer the question. Although this might be a common practice for the scientist herself, the scientific spirit of cybernetics is no longer merely interested in a *phénoménotechnique*, but rather in the technical operation of transposing a *phénoménotechnique* into a different field.

2. Secondly, change, transformation, and novelty are phenomena that can be witnessed and are studied on all levels of being. They are the expression of an *élan*, which is either vital, scientific or encyclopedic. The *élan* is derived out of the sciences themselves: for Bergson the theory of evolution provides evidence of the constant transformation of life. He introduces the concept of the *élan vital* to criticize a reductive interpretation of the theory of evolution. For Bachelard the development of the “new scientific spirit” shows how the transformation of Newtonian physics led not only to a new understanding of substance, matter, and energy that is relevant for the sciences, but also to a new understanding of these concepts in philosophy. Finally, for Simondon cybernetics became the scientific paradigm to inquire into a new epistemology that takes account of the operations between science, philosophy, and technology, while moreover it considers the mode of existence of technical objects in their own right.

3. Thirdly, it follows that science, technology, and philosophy operate within the realm of being. Being is not a structure that is unveiled by scientists or philosophers; rather human beings participate in the transfor-

mative character of being by means of specific forms of practices, such as science, art, and philosophy. Scientific practice is a specific operational mode that creates structures such as the Cartesian plane, Newton's law of gravity, etc. This does not, however, mean that the sciences just construct their world, but that the sciences create structures in exchange with their material, i.e. the world. The question as to whether or not the interrelation of ontology and epistemology begs the question is—to use a famous expression of Bergson—a false one: the epistemic subject cannot avoid to beg the question since it is already operating within a field that exists prior to the epistemic subject. The metaphysical presuppositions allowing for transformation are thus necessary or, to speak with Bachelard, one cannot escape one's metaphysics<sup>2</sup>: metaphysical presuppositions have implications for the observation and creation of scientific phenomena and their interpretation. The epistemological decision to address operations in the sciences and in being originates, however, in the sciences themselves: (1) Bergson shows that the notion of time is reduced to a mere quantitative term in Newtonian physics; (2) Bachelard follows the dynamics of the “new scientific spirit” in the realization of phenomena that cannot become the object of our immediate experience; (3) Simondon takes cybernetics as point of departure and claims that cybernetics itself, without philosophical reflection, is unable to create an axiology since it lacks a proper ontology of values.<sup>3</sup> This axiology is based on the openness of being, which is a common thread that runs through the examined epistemologies.<sup>4</sup> Epistemology is therefore neither a synthesis of the sciences, nor does it belong to the sciences; rather it is a genuine philosophical effort to understand human practices, or as Simondon puts it: an individuation of knowledge.<sup>5</sup>

All three philosophers are not merely interested in describing historical, scientific transformations, but also in the act of transformation itself, which opens new ways of understanding and acting: the epistemic act *is* transformative. Epistemology is thus simultaneously an epistemology of transformation—an epistemology that has as its object the historical transformations within the sciences –, and a transformative epistemology—an epistemology that aims at the transformation of the experience of the epistemic subject.

I will follow these anthropological, epistemological and ontological tendencies in a transductive movement from Bergson to Bachelard to Simondon. Accordingly,

this essay has three parts. In the first part I will develop Bergson's criticism of the sciences along the lines of the *homo faber*. The human being is conceived of as tool making animal. Science is considered as a specific human practice that has the same origins as technology. Science is therefore application-oriented and is creating stable, immobile concepts, which reduce the dynamic and transformative character of life into stable elements. The philosophical task for Bergson is to reverse the usual habit of the human intellect in order to find the origin of experience and to create "fluid concepts." In the second part, I will show that Gaston Bachelard also sees within the sciences a technique at work, but he interprets in opposition to Henri Bergson the role of science entirely differently: science is a practice that allows to open up classical philosophical concepts. The *phénoménotechniques* of the sciences establish a recursive relationship of the epistemic subject with the world. The categories of understanding are transformed by the attempts to realize scientific phenomena. Materiality resists and returns information. The intellectual tools are not stable, but can and have to be modified over the course of time. Bachelard thus reveals the dynamic aspects of the scientific spirit and the plasticity of the human mind. Finally, I will move to Gilbert Simondon, who reacts to the challenges of cybernetics and modern technology: the focus on science and the *phénoménotechnique* shifts towards the operations between particular sciences and towards the mode of existence of the technical object. Simondon develops a conception of the human being in the midst of technical objects—and argues for the development of a "new encyclopedic spirit" that creates a new, open relation with science, technology and the world.<sup>6</sup> In my concluding remarks, I would like to show, how the transformative epistemologies of Bergson, Bachelard and Simondon can contribute to an interdisciplinary anthropology.

## GOING BEYOND THE HUMAN STATE: BERGSON'S PHILOSOPHICAL TASK

Bergson's main metaphysical motif is transformation: life *is* change and evolves via constant transformations.<sup>7</sup> But how can change be addressed and life in its evolution be adequately represented? Since any living being participates in life and its main task is to conserve oneself in life, all its faculties (to feel, act, and think) have to be considered in light of their vital function. According to Bergson, this means that the human intellects<sup>8</sup> most important function is not to contemplate, but to manufacture "artificial objects, especially tools to create tools": to be human means to be primarily *homo faber* and not *homo sapiens*. This definition has two consequences: on the one hand, the genesis of the human intellect is de-

rived out of its exchange with matter; on the other hand, it is application oriented. The scientific practice is therefore only one amongst other human practices. The scientist is the *homo faber* whose toolbox is the scientific method.

It looks as Bergson has formulated a circular argument: the activity of the intellect transforms reality, but a critique of the intellect is only possible by means of the intellect. But as Georges Canguilhem points out in his commentary of the third chapter of *Creative Evolution*: thought is not congruent with the intellect. The intellect is rather a habit of consciousness, a specific style of acting, which cannot generate itself, but has its roots in life itself.<sup>10</sup> Even if the human intellect is manufacturing static ideas and concepts, this work is only possible due to the immediate contact with reality provided by intuition. Since intuition itself is always related to an individual in its relation to the world, intuition signifies an act of an individual. But this act is not merely an intellectual act. Intuition rather suspends the oppositions of subject and object, mind and matter or mechanism and finalism created by the human intellect.<sup>11</sup> The metaphysical task of philosophy is to surpass the human intellectual conditions in an attempt to dissolve the classical oppositions and to enable thought in action, namely intuition. Bergson's answer to the problem of the vicious circle is thus: "action breaks the circle"<sup>12</sup>.

Even if one starts with the discontinued experience created by the sciences, the circle can be broken: Even when complex phenomena, such as emotions, are reduced to stable units that can be measured (e.g. heart rate, skin conductance, neuronal state, intentional object, etc.), which interpenetrate each other in the experience of the emotion, the act of understanding turns into a practice guided by the phenomenon as soon as one attempts to understand the relation between the data and the original phenomenon. The scientist needs therefore at least a certain inherent knowledge to determine a phenomenon, i.e. she needs to know what it feels like to have an emotion in order to determine that a measurement of the heart rate or a galvanic skin response might express elements of an emotion. The composition of the elements alone, however, does not lead to an experience of the whole.<sup>13</sup>

Science and metaphysics differ, however, in their use of intuition. While the sciences are based upon intuition and transform experience into stable units, metaphysics uses intuition methodically and addresses phenomena in their mobility.<sup>14</sup> The intuition already hinted at in the sciences leads to the proper philosophical effort, which aims to go beyond the human state and to search for the sources of

human experience:

It would be to seek experience at its source, or rather above that decisive turn where, taking a bias in the direction of our utility, it becomes properly human experience. ... By unmaking that which these needs have made, we may restore to intuition its original purity and so recover contact with the real. This method presents, in its application, difficulties, which are considerable and ever recurrent, because it demands for the solution of each new problem an entirely new effort. ... [W]hen we have placed ourselves at what we have called the turn of experience, ... there still remains to be reconstituted, with the infinitely small elements which we thus perceive of the real curve, the curve itself stretching out into the darkness behind them. In this sense the task of the philosopher, as we understand it, closely resembles that of the mathematician who determines a function by starting from the differential. The final effort of philosophical research is a true work of integration.<sup>15</sup>

The path is 'of experience' has to be paved via the tools of critique. All the intellectual edifices constructed to fulfill our needs have to be reversed. Yet, this negative work is just the point of departure and the condition of an ensuing constructive effort. Since reality is constantly changing, it is necessary to make each time a new effort to grasp a phenomenon and to create each time a new method.

Bergson connects the "turn of experience" with two transformations: on the one hand, it signifies the place where the human intellect transforms the immediate into the useful; on the other, it is the proper place of philosophy to realize an integral experience from the differential and fragmented experiences. This integral experience is, for Bergson, the proper object of metaphysics, secured by a metaphysical intuition connecting the natural sciences, literature, philosophy and reality. This intuition is, however, not a mystical event that overcomes the subject as revelation. It is rather achieved through "long and intensive fellowship with the facts."<sup>16</sup> Therefore, it cannot be accomplished within the limits of philosophy alone. The exchange with the sciences is necessary to have a comprehensive understanding of the perspectives that are virtually possible.<sup>17</sup> But, while the sciences can only reach a metaphorical understanding of reality, metaphysics is in search for an intuition of the things themselves. "Intuition gives us the thing whose spatial transposition, whose metaphorical translation alone, is seized by the intellect."<sup>18</sup>

But what might be an adequate method to practice metaphysics, if the metaphorical translation of the sciences provides only a spatial transposition? Language constitutes and expresses the condition of scientific research as well as of philosophy. Language operates with concepts, which are the result of intellectual operations condensing dynamic phenomena into stable units. In this sense, they are literally metaphors: transpositions from the realm of operations into stable structures. Concepts are tools applied to reality creating structures of thought.<sup>19</sup> What kinds of action are necessary to break the circle?

## RECAST THE CATEGORIES, CREATE FLUID CONCEPTS!

The aim of the philosophical effort is to enable participation with the *élan vital* creating sense in the universe. Bergson's *élan vital* is characterized by transformation and evolution. Philosophical knowledge is therefore a transformative act. Sense is not achieved, it is not a *telos* that can be reached, but is generated:

The truth is that above the word and above the sentence there is something much more simple than a sentence or even a word: the meaning, which is less a thing thought than a movement of thought, less a movement than a direction. And just as the impulsion given to the embryonic life determines the division of an original cell into cells which in turn divide until the complete organism is formed, so the characteristic movement of each act of thought leads this thought, by an increasing sub-division of itself, to spread out more and more over the successive planes of the mind until it reaches that of speech.<sup>20</sup>

The argumentation approaches its object *ex negativo*: “meaning, which is less a thing thought than a movement of thought, less a movement than a direction.” Bergson attempts here to illustrate the intuition of duration in its transformative movement. We perceive separate things and locate them in order to realize that they are mobile. Yet, this movement is not merely a translocation from A to B, but presupposes a principle of movement in the universe providing a certain direction.

Bergson amplifies this description by an analogy: thought corresponds to the genesis of an organism through cell division. The origin of this process was an impulsion that corresponds to intuition on the intellectual level. The intuition reaches the level of speech (*parole*) in expanding through differentiation. Speech (*parole*)

refers once more to the dissolution of theory and practice. The philosopher is the actual empiricist: experience is not only addressed, but it is performed and experienced in a transformative, epistemic act. Bergson's philosophy neither starts nor ends with pre-existing ideas or structures of knowledge. It rather turns to the mobility of one's mind in vitalizing each time ideas anew when searching for them.

Although the natural sciences also address experiences, they still act within the limits of the *homo faber*. Experience within the constraints of the scientific method is limited to simultaneity and discontinuity. According to Bergson, the sciences do not search for the turn of experience, but rather aim at measurement: "What distinguishes modern science is not that it is experimental, but that it experiments and, more generally, works only with a view to measure."<sup>21</sup>

Bergson does not deny the value of the natural sciences, nor their achievements, but he claims that their methods are inapt to address real transformations *in actu*. His central argument is that movement is divided into merely juxtaposed spatial positions and elements without considering the interval between them.<sup>22</sup> Transformation is, according to Bergson, a continuous process in time that does not allow for discontinuous elements, while the sciences create laws of repetition and measurability. Continuous wholes are thus transformed into discontinuous elements. The philosophical method does not only start with an intuition of a mobile reality, it also aims at an intuition. Intuition—being the mode of immediate experience—allows for participation in transformative processes within the subject *and* the world. The philosophical task is, according to Bergson, to enable transformative processes in recasting the categories of human thought and in creating fluid concepts:

But to do that, it must do itself violence, reverse the direction of the operation by which it ordinarily thinks, continually upsetting its categories, or rather, recasting them. In so doing it will arrive at fluid concepts, capable of following reality in all its windings and of adopting the very movement of the inner life of things. ... To philosophize means to reverse the normal direction of the workings of thought.<sup>23</sup>

The dynamic aspects of reality lead to a universal and at the same time singular experience: an intuition of the "inner life of things." Intuition is restricted to the aspects of reality, which are fluid and in motion themselves. The aim of philoso-

phy is to grasp the mobile reality and to create new, mobile concepts that are able to account for such things in motion.

These things in motion are grasped through an analogous motion of the mind. While working mechanically with matter, the human mind is creating ideas, categories, scientific phenomena and technical objects. In order to understand the vitality of the process, the transformation of dynamic phenomena into stable elements has to be reversed. Thus, philosophy consists in an effort to go beyond the constraints of the *homo faber*: The *homo faber* describes the operational mode of the human mind in its daily routines. These routines encompass daily life practices, body techniques, material production of material tools and the scientific invention of immaterial tools (ideas, categories). Each and every idea, invention etc. is however rooted in an intuition of a dynamic phenomenon, which is then transformed into static elements. As artificial organs technical objects are extensions of the human body that merely imitate nature, but are not producing something genuinely new and independent.<sup>24</sup>

The technical world is for Bergson always related and relying on human beings. The human faculty of the intellect that creates material and non-material tools, is first and foremost interested, according to Bergson, to act on matter. The scientific and technical practices act mechanically on matter and are only able to represent matter mechanically. The sciences and technology have, according to Bergson, only a very limited understanding of matter.<sup>25</sup>

Matter—as a concept of human understanding—is for Bergson the result of the human intellectual practice. The concept of “matter” is a tool the scientist uses to produce results. Bergson conceives of the scientific concept of matter as an empty, merely mechanical entity, without much ontological quality. It is a creation of the human mind. Bergson claims, however, that a different understanding of matter is possible, if one reverses the “normal directions” of our thought. The relations of human practices with matter are thus addressed through a detour: By being reversed, Bergson tries to clarify the ontological and metaphysical prerequisites of the abstract concept of matter and to achieve an intuition of the human practice in its entanglement with the world. To anticipate a Bachelardian term, the practice itself serves as an epistemological obstacle—since it has to be reversed—that is necessary to illuminate the human subject about his situation in and with the world.

We have seen that Bergson conceives of science as a specific human practice: it is a technique to extract stable elements out of the mobile reality. These stable elements can be repeatedly applied to the world and create a stable structures of thought and action. The dynamics of the human mind in applying the scientific technique can only be grasped, if this practice is reversed. Bergson points out that the positive sciences tend to build stable systems and cannot fathom transformations in action, since the sciences are constrained by their essentially technical and application oriented method. In the next part, we will see that Bachelard also focuses on the relation of technology and science, but interprets it entirely differently.

### BERGSONISM DISCONTINUED: ACTIONS OF THE INTELLECT AND THE REALIZATION OF PHENOMENA

Bachelard's philosophy seems to be the exact opposite of Bergson's philosophy: While Bergson's *homo faber*—in using material and intellectual tools—translates the lived, dynamic, and mobile reality into stable, immobile entities, and thus deforms the immediacy of the phenomena in their duration, Bachelard claims that scientific activity renders the conception of the *homo faber* inadequate: While the *homo faber* is adapted to the ordinary, daily life, it cannot adequately describe the scientific development of the electrical, ondulatory and acoustic thought.<sup>26</sup> Whereas Bergson argues that to surpass the human being, one must reverse the activities of the intellect of the *homo faber*, Bachelard makes the opposite claim: modern chemistry,<sup>27</sup> for instance, produces ideas and experiences that are not only the result of a technical realization process, but surpass also the memory, the imagination and the power of comprehension of a singular human subject.<sup>28</sup> This means that the scientific spirit is constantly surpassing the restrictions of the human intellect and consists in a collective effort, where the social, the scientific and the technical sphere are tightly linked and thus constitute the scientific culture.<sup>29</sup> Nature is left behind in the scientific process and human beings enter in a “factory of phenomena” when they think scientifically.<sup>30</sup> The contemporary sciences create a new world and human beings can renew themselves in the “scientific city.”<sup>31</sup>

The infrastructure of this city is built by a constant phenomenotechnical effort to participate in the contemporary debates. The produced phenomena are no longer natural, but technical and social phenomena.<sup>32</sup> Thus, the modern sciences for instance require an essentially social act allowing for the individual subject to

participate and to place oneself in the milieu of the contemporary polemics.<sup>33</sup> In doing so, science cannot be (dis)qualified as either utopian, i.e. too far into the future, nor as erudite knowledge, i.e. an outdated practice unable to produce new phenomena.

This signifies an important difference to Bergson's anthropological notion of the *homo faber*. As long as human beings restrict themselves to the impressions of natural phenomena, they remain themselves natural. As soon as they leave the natural sphere, they can become objective beings.<sup>34</sup> Furthermore, as long as they remain on their own, they stick to their developed habits, their tools and their technical routines.<sup>35</sup> It is the rational activity of human beings that allows them to surpass themselves in opening new ways of self-understanding, objectivity and community. This quasi-humanistic argument is, however, referred back to the principle of life and receives thus an ontological quality resounding Bergson's philosophy of life:<sup>36</sup>

With living beings, it seems that nature is attempting facticity. Life distills and filters. The green planet, forests and meadows, make photochemistry and chemically absorb energy from the sun. But all these pre-human phenomena will be overcome when man reaches the cultural stage. The true working principle of active materialism is man himself, it is the rationalist man.<sup>37</sup>

Even though Bachelard traces the rational activity back to pre-human phenomena, the difference with Bergson is evident: In order to arrive at an active materialism, it is necessary that human beings expand their rational practices. Human beings themselves open up materialism and create new forms of matter with and in the world. Thus, Bachelard's new materialism goes together with an entirely different conception of the human. The *homo faber* does not any longer possess a fixed and static rational structure, but is rather constantly transforming his intellect in applying his intellectual tools. Yet, the practices to produce phenomena and to open materialism are only productive, because they rely on a recursive structure: matter resists the intellect and returns information, when the human intellect is trying to grasp it. The intellect thus returns to itself with new information that initiates the change of its structure. Bachelard's definition of the human does not return to a naïve form of rationalism. The rational does not realize itself easily and without the resistance of matter.

Bachelard exemplifies the recursive relationship of the human, rational subject with contemporary scientific conception of matter in showing that the classical relation of form and matter has been reversed:

It is matter that gives itself a form; it is matter that manifests directly its powers of deformation. Form is not any longer shaped, no longer imposed from the outside. The entire Bergsonism of the *homo faber* appears in its formal perspective, in its ingenious intellectualism as soon as the mixed materials thus act on each other. ... We see the multiplicity of problems a phenomenology aimed at matter raises, a *phénoménotechnique* constantly creating new matters (*matières*), an intermaterialism instructing itself in mutual reactions of various substances. Faced with the hidden nature of matter, it seems that the conscience knows that it must reform its aims, take back its distances.<sup>38</sup>

The rational human being does not only act on matter, but matter acts upon itself and gives itself a form as well. The rational subject participates in processes of material becoming by means of a *phénoménotechnique* that allows her to create new matter, since it is instructed by the reactions of matter itself. This recursive relationship signifies an “era of an open technique,” which, according to Bachelard, has begun within matter itself.<sup>39</sup> Thus, *phénoménotechnique* becomes the faculty par excellence of mankind to perform its transformative task.<sup>40</sup>

## THE ÉLAN OF THE NEW SCIENTIFIC SPIRIT

The human, rational activity to open up concepts is conceived of as a dialectical process inspired by the *new scientific spirit*. Bachelard uses the vocabulary of Bergson to express that “understanding has a dynamic axis, it is a spiritual élan, it is a élan vital.”<sup>41</sup> His criticism of Newtonian mechanism and Cartesian epistemology is similar to Bergson’s criticism of finalism and mechanism in *The Creative Evolution*: (1) the new scientific spirit does not pursue a predetermined goal (*finalism*); (2) it does not work within a determined framework, but is interested in *operative clarity*. The new scientific spirit advances with respect to the “old” Newtonian and Cartesian spirit by replacing clarity “as such” with operational clarity. Being no longer illustrates the relations in being, but the relations illuminate being.<sup>42</sup>

This “realism of relations,” as Jean-Hugues Barthélémy puts it, already anticipates Simondon’s epistemology, where being as such has no longer priority in the

sciences; rather, relations allow to think and know being.<sup>43</sup> The old scientific spirit is only able to illustrate relations within being, i.e. the relations constitute a static framework, which is merely completed by the sciences, while the contemporary sciences illuminate being.

Yet, the old scientific spirit is not entirely negated. Its laws are still valid and used as epistemological obstacles by the new scientific spirit. Within the framework of the old scientific spirit it is, however, impossible to create new phenomena. The old scientific spirit can merely illustrate the relations in being and imitate what is already out there. The old scientific spirit lacks the innovative power, which is revealed in the relations within being. The relations themselves illuminate being and condition the understanding of being as operation.

This understanding of the relation of matter and scientific spirit is simultaneously Bergsonian and anti-Bergsonian: (1) The reference to the concept *élan vital* points to an ontology of transformation in the style of Bergson's philosophy of life. (2) Bergson would, however, point out that life as a phenomenon cannot be grasped by definition within the framework of scientific thought. Bachelard is, interested in the process of conceptualization. Concepts are not stable units, but are developed in historical acts of conceptualization. They are deformed and transformed by the spirit. Science becomes the medium to realize phenomena. Science is neither purely formal nor purely empirical. Concepts are applied to concrete experience, or rather, are virtual experiences that create the object of science. Thus, they are necessarily open and have to be transformed if they encounter obstacles in the process of realization. The dialectics between concepts and epistemological obstacles replace the old image of the relationship between *a priori* and *a posteriori*. They make the epistemological obstacles of the immediate and the general visible and operative.<sup>44</sup> Scientific thought constitutes a recursive relation of theory and praxis: "To think scientifically is to place oneself in the epistemological terrain which mediates between theory and practice, between mathematics and experiment."<sup>45</sup>

Mathematics and experience are the two poles of the field of scientific thought. This field is the condition of possibility of all transformations. Only if it contains a certain tension between spirit and matter can phenomena be produced. This necessary tension already hints at the ontology of Simondon, who stresses the importance of the concept of a 'field.'<sup>46</sup> As we will see in the next section, the clearest example for Bachelard of the importance of such a tension is the transformations

of the conception of ‘substance’ in chemistry. The historical development of this concept shows how philosophy and science influence each other reciprocally.

## OPEN PHILOSOPHY AND THE PLASTICITY OF THE CATEGORIES

The exchange between science and philosophy is necessary in order to create a real philosophy of matter that goes beyond the old philosophical distinctions of idealism and realism as well as of form and matter. These metaphysical dichotomies handed-down in the history of philosophy are not apt to describe the phenomena created by the sciences. The “future science” of matter—chemistry—opens and decenters the classical, core concepts by technical means.<sup>47</sup>

The scientific method is no longer searching for universal, concrete substances, but rather for a systematic blueprint to realize substances. The new scientific spirit is interested in the relations within being and no longer in transcendent forms that have to be realized in each and every singular substance. For Bachelard, scientific reality is thus replaced with a dynamic process of realization. This process of realization constitutes an interplay of *noumenon* and *phenomenon*. Synthetic chemistry describes becoming as a dialogue between substance and energy in focusing on the reactions of substance.<sup>48</sup>

The dialogue between substance and energy refers once more to the notion of the field. Tension between energy and substance is necessary so that material modifications can take place in being. These material modifications transform the energetic state of the substance. The dialogue is not conceived as a continuous and unitary becoming, but rather as an exchange of energies, where differences become measurable and discontinuous to one another. Energy becomes an integral part of substance and receives the same ontological status.

The interpenetration of energy and substance leads to a new, dynamic interpretation of substance. Substance is no longer the keystone of a metaphysical structure, but rather a multitude of rhythms resonating in all limbs of the metaphysical organism to spur it on:

One may even ask oneself if this structured energy, vibrant, a function of a time unit, would not be enough in itself to define the existence of a substance. In this view, substance would be no more than a multiresonant system, a group of resonances, a sort of collection of rhythms ca-

pable of absorbing and emitting certain gamuts of rays. One can foresee, in this sense, a completely temporal study of substances which would be the complement of the structural study. Obviously the door is open to all adventures, to all anticipations. Only a philosopher can rightfully suggest such adventures to the spirit of research. By this piece of intemperance he wishes to demonstrate the sudden plasticity of the categories of understanding and the need to shape more synthetic categories in order to face up to the complexity of the scientific phenomenon.<sup>49</sup>

It is within this context that Bachelard refers to a central philosophical motive of Bergson: A study of substances in terms of time. This focus on substance serves thus as an example of how Bachelard ‘opens’ a concept: (1) it shows the internal difference of the concept to its historical predecessors in the history of the science itself; (2) it draws the consequences for a philosophical and metaphysical understanding of the concept: the concept “opens” the philosophical understanding and reverberates in a different realm and (3) the whole process of creating the concept occurs in a movement from the scientific mind to the concrete experience and back: both, the human mind and the concrete, realized experience have to be open, so that transformation can occur.

This temporal study, complementary to a structural study of substance, is the framework within which the task of philosophy becomes clear. Unlike the sciences, philosophy can undertake this adventure, since it is not its ambition to determine reality in all its elements, but rather to understand the activity of the mind.<sup>50</sup> Philosophy is therefore not primarily searching for a better understanding of reality, but aims to examine the processes of transformation in action. In proving the plasticity of the categories of human understanding, philosophy becomes relevant for the sciences: the philosopher provides a theoretical foundation for the scientific practice where theory prepares concrete phenomena and is corrected by experience. The foundation itself is not unchangeable. The transformative nature of the new scientific spirit also applies to metaphysics and philosophy:

In a philosophy of no a new metaphysical shade of meaning makes its appearance in the notion of substance. In order to underline forcefully the fact that substance is defined by a group of external determinations, arranged in such a way that they cannot together achieve enough precision to acquire absolute interiority, one might perhaps enlist the term *ex-stance*. Accordingly, *sub-stance*, *sur-stance*, *ex-stance*, such would be—for

want of a better term—the play of pure concepts necessary for the classification of all the tendencies of metachemistry.<sup>51</sup>

This quote clearly shows the recursive relationship of philosophical reflection and scientific practices. If philosophy wants to play a part in the production of knowledge, it has to deal with the sciences. The philosophy of no has to open up and to create concepts to identify and highlight the transformations in the sciences. This means that, for instance, the notion of substance can always receive new metaphysical nuances. The point of departure of this process of opening (*ouverture*)<sup>52</sup> is an epistemological obstacle. The concept of substance blocks the path of the new efforts of realization. Within the new scientific framework, the classical understanding of substance can no longer be realized. It has to make way for a new, open form of conceptualization: “The process here is from a closed, blocked, linear conceptualization to an open, free, many branching, conceptualization, free from the fusion of experience and primitive thinking.”<sup>53</sup>

This does not mean, however, that philosophy becomes the subservient to the natural sciences and its ontology; rather, through the sciences new ontologies become possible. This creative and transformative potential cannot be found in stable metaphysical systems where the final goal or a comprehensive reality is pre-given. Epistemology has to become as mobile as the scientific spirit.<sup>54</sup> Philosophy consists in a process of thought that is constantly in search for its object, challenges its own categories, and abandons them when their potential to realize phenomena is lost.<sup>55</sup> The task of the philosopher consists in a constant effort and exercise to modify axioms:

But this coherence must be lived through in its proper place by the philosopher; it is not automatic, it is not done easily. The philosopher who wants to learn surrationalism cannot come to it all at once. He must experiment by opening up rationalism in successive stages. He must seek out the axioms to be dialectized one by one. Just one dialectized axiom brings all nature out in choral song. In my own experience, surrationalism, I have found, never has more than one sharp or one flat in its key-signature.<sup>56</sup>

The philosophical work on concepts is a collective and interdisciplinary act: Philosophical concepts are developed in contrast to and in dialogue with other philosophical positions. The sciences, however, apply concepts and test their concrete performativity in order to create experiences. These processes of transformation

are the primary subject of philosophy, where concepts can be created that do not only leave impressions in the academic armchair, but are efficient in their realization and produce phenomena. Opening a concept thus goes into two directions: It opens the concept internally, i.e. the concept is dialectized (*dialectisée*), and the spectrum of meaning within a concept is thus enlarged, while simultaneously the experience is specified (*précisée*).<sup>57</sup>

Philosophy consists thus in an effort to search for and to establish the recursive relationship with the sciences. We have seen that Bachelard—as Bergson—formulates the goal of philosophy as a surpassing of the constraints of the human intellect. In contrast to Bergson, however, the concept of matter in the sciences is not abstract and devoid of dynamic elements, but rather the result of the recursive relationship of the scientific human mind with matter. The confrontation with the sciences allows us to open up philosophical concepts. The sciences play, so to speak, the part of epistemological obstacles for the philosopher that are necessary to leave its preconceived ideas and categories behind.

#### SIMONDON'S EPISTEMOLOGY OF CYBERNETICS OR THE NEW ENCYCLOPEDIA SPIRIT

This recursive characterization of philosophy is also at stake in Simondon's interpretation of cybernetics. Philosophy, Simondon tells us, is not a specific domain or area that can be delimited. It is not an application of a specific form of thought to defend spiritual or temporal interests. Its function is rather to be open to foreign domains, in which problems of human existence arise, in order to ascertain, actualize and examine the problem. This new problematic occurs in what Norbert Wiener calls the "no man's land" between the sciences. But here, it is no longer science that challenges philosophy to rethink its categories but the development of new techniques. On the one hand, machines have received an autonomy and do not need the human being as source of energy anymore. On the other a science can itself become a technique: when a problem in a specific scientific field arise and another science is as technique imported to solve the problem.<sup>58</sup>

These new techniques are closely bound to the development of a new conception of the human. Simondon's critique of the *homo faber* is analogous to Bachelard's, but goes in some aspects even further: for Simondon, cybernetics and the theory of information have shown that technical objects have a mode of existence that is independent of the *homo faber*.<sup>59</sup> A unilateral relation of human beings to tech-

niques can neither explain technical objects, nor can it account for the reciprocity of the interactions of humans with technology. Human beings are no longer acting with mere tools to structure their reality, but are rather entangled in a network of technical objects, which they must coordinate and re-invent continuously.<sup>60</sup>

This situation no longer describes the unilateral access to the reality of *homo faber*, but of a *homo coordinans*, who is not only structuring reality with his toolbox or creating new phenomena by technical means: the *homo coordinans* is also coordinated by the technical realm.<sup>61</sup> Technical objects are no longer conceived as mere structures mediating operations, but as a specific operational mode. The technical object entertains therefore not only relations with the human being, but also with nature. Reducing the technical to its use is missing this specificity of the technical object.

Xavier Guchet points out that Simondon reproaches both Bergson and Bachelard. According to Simondon Bachelard misunderstood the value of the technical object in confusing the operational and the practical level: Machines are according to Simondon physico-chemical systems that lend themselves to an inductive study. The genuine technical operation makes, as does the scientific instrument, nature accessible for knowledge.<sup>62</sup>

It was precisely this misunderstanding of technical activity that led, according to Simondon, to an emergency-call of technique to philosophy mediated through cybernetics.<sup>63</sup> Until cybernetics entered the scene the technical was considered as an entity without problems and interiority.<sup>64</sup> As a product of human creativity, it was considered to be explainable in human terms. According to Simondon, this only partially deals with the technical sphere: technical objects do not merely consist of human elements; rather, they enclose relations of the human being to the world and of consciousness to nature.<sup>65</sup> The technical operation reveals, therefore, even on its most basic levels a recursive relationship of form and matter, of structure and operation.<sup>66</sup>

Although this is also the case for the production of scientific phenomena, as we have seen above, the relation of structure and operation is reversed. While science determines objective structures by inventing operations (i.e. specific methods to create phenomena or, to speak with Bachelard, *phénoménotéchniques*), technique produces operations by inventing structures: “science determines objective structures by inventing (*en inventant*) operations, whereas technique produces

operations by inventing structures.”<sup>67</sup> It is important to note that the French *en inventant* points to a simultaneity of structure and operation. Science invents operations and simultaneously determines objective structures. Techniques invent structures and produce simultaneously operations, e.g. the invention of the motor is the invention of a structure that produces a specific operation, which defines it as a motor.

This diametric relation of science and technique as well as of structure and operation illustrates in a nutshell the new problem that arose with cybernetics: due to the particularization of the sciences, a multitude of methods and operations exist next to each other. Universal geniuses, such as Leibniz, who had a comprehensive grasp of the sciences as such, do not exist anymore. Rather, specialists delimit their specific fields and are not interested in the neighboring field.<sup>68</sup> The question for the cyberneticists—and also for Simondon—was, how do the sciences relate to one another? Is there a general method that allows for movement from one science to another?

## THE NO-MAN’S LAND AND THE ALLAGMATIC METHOD

Simondon interprets cybernetics as the science capable of performing this task. But as opposed to Norbert Wiener, whose metaphor of the *no man’s* land suggests that a proper domain of cybernetics exists,<sup>69</sup> Simondon claims that cybernetics might evolve into a similar compartmentalized science developing branches of cybernetics, such as servo-mechanics, a theory of influx etc.<sup>70</sup> Instead of searching for the promised no man’s land, cyberneticists should realize that they just have a complementary view of the “same” world.<sup>71</sup> The philosophical task, which Simondon derives out of the discussion of cybernetics, is therefore to “invent a new structural notion allowing to develop an universal *allagmatic*.”<sup>72</sup>

This new *allagmatic* is the “method of operations.”<sup>73</sup> It is “symmetrical to the theories of structures in the particular sciences.”<sup>74</sup> Whereas the “sciences” deal with “structures,” the allagmatic method searches for the realms where these operations take place. The allagmatic method is marked by its two constitutive modes: on the one hand, it has “operations” as its object; on the other, it has to be itself an “operation” that provides communication between formerly separated levels of being.<sup>75</sup>

Due to its interest in feedback mechanisms and exchange of information, cybernetics addresses these operations on a different reflexive level than the particular sciences. Simondon defines the work of the particular sciences in Bachelardian terms:

However, science aims, in each domain, at a theoretization of experience. The scientific gesture is free. Only the theoretical result of this gesture matters. The operational activity of science has in each domain only one control: the compatibility with experience, therefore with the object.<sup>76</sup>

The scientific gesture realizes the compatibility of theory with experience, of the abstract with the concrete, of mind and object. This relation signifies the knowledge of an isolated system. Science “determines objective structures,” as we have seen above. A new, different mode of knowledge must therefore be developed to open the isolated systems to one another. This *inter-* or *super-scientific* knowledge is, according to Simondon, universal technological knowledge (*savoir technologique universel*):

Within the operational inter-scientific if not supra-scientific compatibility a mode of relation to the object is discovered, which is no longer scientific but technical. The technical subject-object relation is richer than the scientific relation. The latter is abstract and concerns a limit case of an object not modified by the realization of consciousness and without relation to the world (isolated system). The technical relation on the contrary considers the object in its concrete totality of its aspects, in its relation with the subject of knowledge and the world. The *no-man's land* in between the particular sciences is not a particular science itself, but a universal technological knowledge. An inter-scientific technology that does not consider a theoretical *object*, cut out of the world, but a *situation*.<sup>77</sup>

While the scientific object is merely considered in its relation to the knowing subject, the technical object is considered in its relation to both the world and the knowing subject. Focusing on the relations between the sciences, or entering *no-man's land*, opens a specific science in relating it to the world that surrounds it. Due to its technical structure, the operations at work on different levels of being can be addressed. This does not, however, mean that one operation is reduced to another, but that operations can be *equivalent* to one another:

One can call a situation *equivalent* to another, if the same technical gesture modifies both situations in the same way. Equivalency is not an identity of the *nature of objects*, but an *operational activity*, which has to be exercised on them [the nature of the objects] to modify them in the same way. It is an analogy, if one understands analogy as a relation not of identity (resemblance or similitude), but as identity of relations, and to specify, *operational relations*.<sup>78</sup>

The technical gesture, which modifies a specific situation, allows us to relate different domains to each other. It is, however, important to note that it is a technical gesture and not a technical structure that allows for equivalency. Although structure and operation are, according to Simondon, complementary to each other, operation nevertheless has priority.<sup>79</sup> The technical gesture is therefore an operation of its own that relates different operational modes with each other. It leads to the philosophical gesture, which, according to Simondon, aims at grasping the moment where structure turns into operation or operation turns into structure. This transformative experience is the “cogito of a new, reflexive philosophy”:

This cogito of a new reflexive philosophy, where the function grasps itself in its functioning, allows, after the ontological culmination, which marks the equivalency of being and acting, between operation and structure, to found an axiology. According to the cybernetic method, the only valuable axiology is an axio-ontology.<sup>80</sup>

This “axio-ontology” cannot, however, be derived from cybernetics itself, since there is still a crucial difference between cybernetics as a science and philosophy. As already mentioned, the operational mode of philosophy is not exclusive. It does not delimit its proper domain in contrast to other domains, but is in its essence open and able to change its structure. This openness is precisely how Simondon defines value: The change or transformation of a structure.

## THE NEW ENCYCLOPEDIA SPIRIT

Yet, structural change only occurs, if a “thanatological element” enters a holistic system and creates a problem, which threatens the living being in its existing structure. This thanatological element cannot be grasped with the concepts applied by cybernetics to describe vital processes—namely *negentropy* and *homeostasis*—since they represent merely a function respective to a teleological mechanism

of the living being:<sup>81</sup> The living being, thus defined, does not change its structure, but increases its organization (*negentropy*) to remain the same (*homeostasis*).<sup>82</sup> Simondon turns cybernetics against itself: although cybernetics is right in addressing the question of information, it cannot formulate the question adequately in its own terms when it comes to living systems. Here, a non-probabilistic conception of information becomes necessary, in order to explain how a specific form is of higher quality in a specific holistic system or why a system needs to change its structure.<sup>83</sup>

This qualitative notion of information is rendered possible by the philosophical effort, which makes a certain problem within a domain conscious that cannot be resolved within the domain by itself. Insofar, philosophy operates in analogy to cybernetics. The philosophical effort leads, however, not only to a consciousness of the system itself, but it also opens the system in providing culture. Culture in return, is defined as contact with a universal totality of systems, a contact with an “imaginary or real holistic system” capable of incorporating all other systems.<sup>84</sup> The philosophical effort thus solves a particular problem in integrating it in a general problematic and opening it for other systems:

The philosophical effort therefore provides a contact with a real universality. It integrates a system hitherto isolated in the immense society of systems. It solves a particular problem in integrating it in a general problem and it makes the solitude of problems cease to create a world of problems. It opens thus a system to relate it to others, due to a change of plan. The philosophical effort modifies in its encyclopedic intention in the Hegelian meaning of the term the individuality of the problems in striving towards the most synthetic and highest problem.<sup>85</sup>

While a problem remains bound to a specific situation and has—since problems arise only for living beings, i.e. individuals<sup>86</sup>—individuality, the philosophical effort can relate it to a different, higher, and more abstract sphere. This does not mean that the individuality of the problem is lost, but that it is posed in a different, metaphysical way. The encyclopedic intention is that the individual understands the problem itself and relates it to a higher holistic system. The holistic system to which the individual relates is neither given in advance, nor is it a system that realizes itself during the course of history. The axio-ontology is not based upon the existence of the higher holistic system, but on the ability of the individual to perform the technical, scientific and philosophical gestures: to grasp itself and its

relation to the world in the act. The value, the new axiomatic structure of operations is based upon, is the transformative character of being itself. This capacity is found, according to Simondon, in the individual itself prior to any distinctions.<sup>87</sup> Within the individual, a structure and operation are intrinsically linked without reducing one to the other. Within the individual both, structure and operation, are convertible and equivalent to each other.

The epistemological task is to facilitate transformative operations in a philosophical gesture in its encyclopedic intention. The reference for Simondon to develop a “new encyclopedic spirit” does not, however, only come from Hegel, but also—and more importantly—from Diderot and Alembert, as well as from the Sophists in Antiquity, from Plato, and finally from the modern cyberneticists.<sup>88</sup> The encyclopedic spirit has, therefore, a certain methodology: Its central point is that it allows for a general public access to technical knowledge. In doing so, it aims, according to Simondon, at a unification of operations and is itself a tool allowing individuals to reinvent and actualize technical gestures.<sup>89</sup> It consists of a description of tools, and technical apparatus is not restricted to written language, but uses plates, graphics and schemata to allow as many recipients as possible to participate in the technical developments. Its recipients and the form in which the technical operations are interpreted are not yet defined, but are virtual and open.<sup>90</sup> The encyclopedia applies an operation, namely schematization, to instruct its reader of its operational mode.

Simondon describes the encyclopedia as a machine that needs to be reinvented by a human gesture:

All encyclopedic machines necessitate and call for a human gesture to put them into action: the shape of the *pinax* is followed by the finger or by the look, indentation after indentation; one pores over the book, since it refers from one article to another; one commands an automatic filing system starting from a central platform. But to consider the *pinax* statically, to read a printed encyclopedia alphabetically, to let an automatic filing system work by chance, means to consider operational machines structurally and not to account for its encyclopedic meaning. The modern encyclopedists are the modern scientist, that is the cyberneticians, these technicians of information, who work in teams and think communally, driven by their faith in this new postulat: logical empiricism.<sup>91</sup>

The epistemological task comprises three elements: (1) the encyclopedia is described as a machine that calls for a human gesture. The *pinax*, in this case the writing tablet of Thales, has to be touched or perceived: the book is pored over, since its articles are an integral part of a system of references that have to be understood as specific operational mode of the encyclopedia. One navigates through a data system starting from the home screen: structure and operation belong here together. Although structure is necessary, it is not preferred over and against operation. (2) The gesture requires a specific, epistemological attitude towards the encyclopedic machine to be realized. One has to search for the operational mode and fathom the machine in analogy to oneself in order to understand it. Neither book, nor computer, nor basic writing tool can be considered merely as structure. Understanding the machine in analogy to oneself leads therefore not only to a genuine understanding of the machine, but also to a better self-understanding. The encyclopedia signifies a machine that mediates the production of a new perspective. (3) The encyclopedic spirit is a collective, interdisciplinary effort.<sup>92</sup> It facilitates the operation to relate the individual to different technical and intellectual systems. The compartmentalization of the sciences necessitates this collective effort. An individual scientist is no longer able to comprehend all the methods that are at work in the particular sciences. Cybernetics is thus a role model of interdisciplinary research: it is not interested in the definition of a particular field, but its operations attempt to understand “control” and “communication” as such, without being limited to a specific domain. The collective effort is the philosophical gesture as such, attempting to relate to universality, yet this universality is not a closed system, but the mode of operation of individuals in their tension with the milieu as such.

Simondon combines in an original way the epistemologies of Bergson and Bachelard. While he still holds that sciences tend to develop isolated systems—an argument echoing Bergson’s criticism that the sciences transform the mobile reality into stable elements—, Simondon is also aware of the productive aspects of the *phénoménotechniques* of the sciences and the dynamic character of the scientific mind as well as of technology. We have seen that he focuses on the technical gestures and operations themselves that do not only allow to realize phenomena, but also to mediate between the sciences: Operations he exemplified and sees at work in the encyclopedic spirit.

## CONCLUSION

The transformative epistemology, I described in this article, followed different forms of an *élan*: it moved from the *élan vital* to the *élan scientifique* to the *élan encyclopédique*. I attempted to show that each of these epistemological movements consists itself in an operation, an epistemic act, which can open and transform static structures. This act ties anthropology, epistemology and ontology together: epistemology does not occur in an abstract realm, but is, as are scientific practices, realized by a subject in the world. This “applied metaphysics”<sup>93</sup> of Bergson, Bachelard and Simondon, invites the human subject to participate in the transformations of life and knowledge.

Although the differences between Bergson, Bachelard and Simondon are significant, all three of them are advocates of a transformative epistemology of openness. Their philosophies are inspired by a humanistic impetus that challenges human beings to understand themselves in their relationships with their scientific, social and technical environments. Their epistemological projects address human practices on different levels and relate them to each other. This effort to relate different domains to each other, can be understood as interdisciplinary anthropology: the human is no longer considered from an essentialist vantage point. The anthropological question is, within this interdisciplinary anthropology, not “what is the human being?,” but rather “what does a human being do and what are its relations to and with the world?” This praxeontological move emphasizes the necessity of the human subject to create symmetry between different types of being, rather than sacrificing it for a transhumanist position.

Reading Bergson, Bachelard and Simondon together provides thus a methodological reflection on the conditions of possibility of an interdisciplinary anthropology that addresses human practices *within* and *in between* the different sciences.<sup>94</sup> I therefore understand interdisciplinary anthropology not as a particular discipline or as a preconceived method, but as a philosophical effort to raise, develop and pose the anthropological question in exchange with the sciences.

Bergson, Bachelard and Simondon show that this effort is a necessarily open endeavor: It relies upon an ontology that allows for openness, transformation and symmetry. Epistemology and philosophy are not excluded from the constant transformations of life and mind. This means in turn, that the epistemological project is necessarily open. The epistemic act is not merely transforming the rela-

tion to the world, but also transforms the subject itself and provides the means in its encyclopedic effort to create new modes of humanism.<sup>95</sup>

## NOTES

1. Ultimately, this is the classical problem of Aristotle's *Metaphysics*. Aristotle uses the famous analogy of the nektyris (bat or nightowl) to describe the relation of the human intellect to its first principles: "Just as it is with bats' eyes in respect of daylight, so it is with our mental intelligence in respect of those things which are by nature most obvious." Aristotle, *Metaphysics*, 993b9.
2. Gaston Bachelard, *Le nouvel esprit scientifique*. Paris: Presses Universitaires de France, 1934.
3. Gilbert Simondon, "Cybernétique et philosophie" *Sur la philosophie*. Gilbert Simondon, Paris: Presses Universitaires de France, 2016, 63.
4. Gilbert Simondon, *L'individuation à la lumière des notions de forme et d'information*. Grenoble: Éditions Jérôme Millon, 2013, 324f.
5. Simondon, *Individuation*, 36.
6. Jean-Hugues Barthélémy calls Simondon's position a "difficult humanism." See: Jean-Hugues Barthélémy, *Simondon ou l'encyclopédisme génétique*. Paris: Presses Universitaires de France, 2008.
7. Henri Bergson, *Creative Evolution*. Transl. by Arthur Mitchell. Mineola/New York: Dover Books on Western Philosophy, 1998, 30f.
8. I am aware that Bergson rather uses *intelligence* than *intellect*. *Intelligence* indicates a natural, immanent faculty that came about in the course of the evolution of life. *Intellect*, however, implies the Aristotelian transcendental faculty. Yet for Bergson, intelligence/intellect does not imply a hierarchical distinction. Instinct and intelligence/intellect are for him, although they differ essentially, two solutions of vital problems. I chose to use intellect rather for reasons of coherence with the English translations (who from time to time translate intelligence with intellect or with intelligence), but I ask the reader to keep the immanent character of the human intellectual faculties in mind.
9. Bergson, *Creative Evolution*, 139.
10. Georges Canguilhem, "Commentaire au chapitre iii de l'Évolution créatrice de Bergson [1943]," in: Frédéric Worms Ed., *Annales bergsoniennes, vol. iii, Bergson et la science*, Paris: Presses Universitaires de France, 2007, 132.
11. Canguilhem, "Commentaire," 132-134.
12. Bergson, *Creative Evolution*, 193.
13. See for a discussion of intuition and emotion: Johannes F.M. Schick, "Intuition et émotion: une relation méconnue," in: Arnaud François, Anthony Feneuil, Ghislain Waterlot (Eds.), *Annales Bergsoniennes VIII: Bergson, la morale, les émotions*, Paris, Presses Universitaires de France, 141-167 and Johannes F. M. Schick, *Erlebte Wirklichkeit. Zum Verhältnis von Intuition zu Emotion bei Henri Bergson*. LitVerlag: Münster/Berlin, 2012.
14. Henri Bergson, *The Creative Mind: An Introduction to Metaphysics*. Trans. Mabelle L. Andison. Mineola/New York: Dover Books on Western Philosophy, 1946, 33.
15. Bergson, *Matter and Memory*, 184f.
16. Bergson, *Creative Mind*, 169.
17. Philosophy and science both are collective efforts that share a methodological impetus of constantly adapting to the phenomena: "For in this view, philosophy is no longer a construction, the systematic work of a single thinker. It needs, and unceasingly calls for, corrections and

re-touches. It progresses like positive science. Like it, too, it is a work of collaboration.” Henri Bergson, *Mind Energy. Lectures and Essays (translated by H. Wildon Carr)*, New York: Henry Holt and Company, 1920, 7.

18. Bergson, *Creative Mind*, 55.

19. Bergson formulates his critique of language already in the first passage of the *Essai sur les données immédiates de la conscience*. The translation of temporal phenomena into spatial terms is one of the central motives of Bergson’s philosophy. Henri Bergson, *Essai sur les données immédiates de la conscience*. Edition critique sous la direction de Frédéric Worms, Paris: Presses Universitaires de France, 2007 [1889], 1.

20. Bergson, *Creative Mind*, 100.

21. Bergson, *Creative Evolution*, 333.

22. Bergson, *Creative Mind*, 139.

23. Bergson, *Creative Mind*, 224f.

24. Henri Bergson, *Les deux sources de la morale et de la religion*. Edition critique sous la direction de Frédéric Worms. Paris: Presses universitaires de France, 2008 [1932], 330.

25. Bergson, *Les deux sources*, 145.

26. Gaston Bachelard, *Le rationalisme appliqué*, Paris: Presses universitaires de France, 1966<sup>3</sup> [1949], 163.

27. Although any particular science, such as physics or biology, can produce new ideas and impact philosophy, chemistry was particularly important for Bachelard. Cf. Christina Chimisso, “A matter of substance? Gaston Bachelard on chemistry’s philosophical lessons” In: Galavotti, Maria Carla; Nemeth, Elisabeth and Stadler, Friederich eds. *European Philosophy of Science - Philosophy of Science in Europe and the Viennese Heritage*. Vienna Circle Institute Yearbook, 17. Springer, 2013, 33–44.

28. Gaston Bachelard, *Le matérialisme rationnel*, Paris: Presses universitaires de France, 1972<sup>3</sup> [1953], 1.

29. Gaston Bachelard, *L’activité rationaliste dans la physique contemporaine*. Paris: Presses Universitaires de France, 1965, 10. Bachelard’s position that science, technology and society are inter-related is in the contemporary debate in the Science and Technology Studies often overlooked. Juliette Grange, for instance, argues to revisit Bachelard over and against Simondon and Latour (Juliette Grange, “L’invention technique et théorique : la philosophie des sciences de G. Bachelard.” *Imaginaire, Industrie et innovation*. Ed Pierre Musso, Cerisy-la-Salle (September 2015), <https://halshs.archives-ouvertes.fr/halshs-01336345/document> (last visit: 02/04/2018).

30. Bachelard, *Activité rationaliste*, 10.

31. Bachelard, *Matérialisme rationnel*, 2.

32. Bachelard, *Matérialisme rationnel*, 31.

33. Bachelard, *Activité rationaliste*, 8.

34. Bachelard, *Activité rationaliste*, 7.

35. Bachelard, *Activité rationaliste*, 14.

36. Jean-Jacques Wunenburger points out that both Bachelard and Bergson refer to a primitive force in the universe even though they differ in significant points: “Chez Bergson, l’action d’une force primitive dans le cosmos ou dans la Nature est ainsi censée se prolonger dans la conscience, qui puise dans ce dynamisme la capacité de mobilisation et de créativité psychique

et intellectuelle. Chez Bachelard, une tonalité vitale, proche à certains égards d'un vouloir-vivre schopenhaurien va doter la rationalité scientifique et l'imagination poétique d'une puissance plastique de transformation des représentations. La référence à une semblable force primitive va donc leur permettre d'éclairer les processus de complexification de la vie de l'esprit, même si la médiation du langage inhibe, voire masque l'élan vital chez Bergson, alors qu'elle se présente comme la forme irréductible à travers laquelle la pensée active un dynamisme élémentaire chez Bachelard." (Jean-Jacques Wunenburger, "Force et résistance, le rythme de la vie" *Bachelard et Bergson. Continuité et discontinuité*. Eds Frédéric Worms, Jean-Jacques Wunenburger, Paris: Presses universitaires de France: 2008, 28).

37. Bachelard, *Matérialisme rationnel*, 32f [Translation J.F.M. Schick].

38. Bachelard, *Matérialisme rationnel*, 16 [Translation J.F.M. Schick].

39. Bachelard, *Matérialisme rationnel*, 115f.

40. Bachelard, *L'activité rationaliste dans la physique contemporaine*, 4.

41. Bachelard, *Nouvel esprit*, 179.

42. Bachelard, *Nouvel esprit*, 148.

43. Jean-Hugues Barthélémy, *Penser l'individuation. Simondon et la philosophie de la nature*, Paris: L'Harmattan, 2005, 20. This is also the case for Michel Serres as Massimiliano Simons shows in his contribution to this Special Issue.

44. Bachelard, *Philosophy of No*, 5. and Gaston Bachelard, *La formation de l'esprit scientifique*, Paris: Presses Universitaires de France, 1934, s. chapter 3

45. Gaston Bachelard, *Philosophy of No. A Philosophy of the New Scientific Mind*, New York: Orion Press 1968, 6.

46. Jean-Hugues Barthélémy suggests that Bachelard provided the groundwork for Simondon's ontology. While the ontology was implicit in Bachelard, Simondon makes it explicit. See: Jean-Hugues Barthelemy, 'D'une rencontre fertile de Bergson et de Bachelard,' 232f, in: Frédéric Worms, Jean-Jacques Wunenburger (Eds.), *Bachelard et Bergson. Continuité et discontinuité*, Paris: Presses universitaires de France: 2008, 223-238 and Jean-Hugues Barthélémy, 'Théorie de la connaissance et relativité philosophique,' in: Jean-Jacques Wunenburger (ed.), *Gaston Bachelard: Science et poétique une nouvelle éthique?*, Paris: Éditions Hermann, 75-87.

47. Bachelard, *Le matérialisme rationnel*, 24. Bachelard shows that chemistry is in need of what he calls a "metachemistry," just as physics has its metaphysics. This metachemistry would have the same relation to metaphysics as chemistry to physics (Bachelard, *Philosophy of No*, 45). Metachemistry and metaphysics are the conditions of possibility of a science to critique its own foundations. In the case of chemistry the metaphysical or better 'metachemical' presuppositions, are changed in the transition from seeing chemical substances as bodies that can become objects of our immediate experience to seeing them as products of scientific and technical means. The transformation of the concept of substance within chemistry thus shifts from a naive, prescientific realism towards a mature scientific concept. From the latter perspective, the immediate experience does not have to correspond with the scientific experience. The new concept of substance structures our experience and enables a phenomenon that contradicts the intuitions of our daily life. Moreover, Bachelard claims that within chemistry existence is never a monotonous function, but rather allows for a multitude of tones (Bachelard, *Philosophy of No*, 46). A specific substance is therefore not always constituted in exactly the same way, but it can vary on different levels and does not have any predetermined coherency. For a study concerning

the relationship of metaphysics and metachemistry see Alfred Nordmann, ‘From Metaphysics to Metachemistry.’ *Philosophy of Chemistry: Synthesis of a New Discipline*, in the series *Boston Studies in the Philosophy of Science*. Eds Davis Baird, Eric Scerri, Lee McIntyre, Dordrecht: Springer, 2006, 347-362. Nordmann argues that Latour, in his “Pandora’s Box,” makes” a “metachemical argument” although he tends to overlook the works of Bachelard and Meyerson.

48. Bachelard, *Philosophy of No*, 56.

49. Bachelard, *Philosophy of No*, 58f.

50. For a comprehensive study of the development of “historical epistemology” in France see: Christina Chimisso, *Writing the History of the Mind. Philosophy and Science in France, 1900 to 1960s*, Hampshire (UK): Ashgate Publishing, 2008.

51. Bachelard, *Philosophy of No*, 66.

52. Bachelard’s notion of *ouverture* is inspired by Ferdinand Gonseth. For a detailed, historical discussion of the influence of Gonseth on Bachelard, see Carlo Vinti, “Présence de Ferdinand Gonseth dans la pensée de Gaston Bachelard” *Revue de synthèse : 5e série*, 2005/2, 391-415 and Vincent Bontems, ‘L’éthique de l’ouverture chez Gaston Bachelard et Ferdinand Gonseth,’ in: Jean-Jacques Wunenburger (ed.), *Gaston Bachelard: Science et poésie une nouvelle éthique?*, Paris: Éditions Hermann, 379-397

53. Bachelard, *Philosophy of No*, 113f.

54. Bachelard, *Rationalisme appliquée*, 10.

55. Bachelard, *Nouvel esprit*, 181-183.

56. Bachelard, *Philosophy of No*, 118.

57. Bachelard, *Rationalisme appliquée*, 139. See also: Bonicalzi, “Gaston Bachelard: épistémologie ouverte et éthique de la connaissance,” 20f.

58. Simondon uses the term “technique” to address technical phenomena in general. He makes, however, the important distinction between “technique” and “technologie” to describe cybernetics as a science of techniques (Gilbert Simondon, “Cybernétique et philosophie,” 40).

59. Gilbert Simondon, *Du mode d’existence des objets techniques*. Paris: Aubier, 1958.

60. Simondon, *Mode d’existence*, 11f.

61. Johannes F.M. Schick, “Theaters of Individuation: Simondon and the Interrelations of Ethics, Techniques and Ontology” in: *Journal of Badiou Studies* 5: Archithéâtre, <https://badioustudies-journal.org/architheater/>. 2017.

62. Xavier Guchet, *Pour un humanisme technologique. Culture, technique et société dans la philosophie de Gilbert Simondon*. Paris: Presses Universitaires de France, 2010, 180.

63. Simondon, “Cybernétique et philosophie,” 38.

64. Simondon, “Cybernétique et philosophie,” 38.

65. Simondon, “Cybernétique et philosophie,” 38.

66. Simondon, *Individuation*, 40f. Simondon explains in his thesis on individuation (first published 1964) using the production of a brick as example that the process of individuation cannot be reduced to a relation of an ideal form and pure matter: the materiality of the form takes as well part in the process of production as is the specificity of the material filled into the form. Form and matter entertain an intricate, recursive relation while the brick is produced. That means, matter has to be prepared and informed in the process of production.

67. Gilbert Simondon, “Épistémologie de la cybernétique” *Sur la philosophie*, Gilbert Simondon, 186 [Translation J.F.M. Schick].
68. Simondon, “Cybernétique et philosophie,” 39.
69. Simondon, “Cybernétique et philosophie,” 39; Norbert Wiener, *Cybernetics or Control and Communication in the Animal and the Machine*. Cambridge, Massachusetts: M.I.T. Press, 1948, 2.
70. Simondon, “Épistémologie de la cybernétique,” 185.
71. Simondon, “Épistémologie de la cybernétique,” 185.
72. Simondon, “Épistémologie de la cybernétique,” 185.
73. Jean-Yves Chateau, *Le vocabulaire de Simondon*. Paris: Ellipses, 2008, 11.
74. Gilbert Simondon, “L’Allagmatique,” 529, *L’individuation*. Gilbert Simondon, 529-536.
75. Simondon, “Allagmatique,” 529 [Translation J.F.M. Schick].
76. Simondon, “Cybernétique et philosophie,” 40f [Translation J.F.M. Schick].
77. Simondon, “Cybernétique et philosophie,” 41 [Translation J.F.M. Schick].
78. Simondon, “Cybernétique et philosophie,” 42 [Translation J.F.M. Schick].
79. Simondon, “Allagmatique,” 534. This preference of operation is based upon Simondon’s ontology, which is intrinsically linked with epistemology and the methodical use of analogy. The concept of analogy hinges for Simondon on the understanding of being: beings have to be inseparably linked to their mode of action—their operation—in order to apply the “method of analogy.”
80. Simondon, “Cybernétique et philosophie,” 62.
81. Simondon, “Cybernétique et philosophie,” 62.
82. Wiener, *Cybernetics*, 11.
83. Gilbert Simondon, “Forme, information et potentiels,” 549, *Individuation*. Gilbert Simondon, 537-558.
84. Simondon, “Cybernétique et philosophie,” 62 [Translation J.F.M. Schick].
85. Simondon, “Cybernétique et philosophie,” 62.
86. Simondon, *Individuation*, 213f.
87. Simondon, *Individuation*, 535.
88. Gilbert Simondon, ‘Les encyclopédies et l’esprit encyclopédique,’ 121ff. *Sur la philosophie*. Gilbert Simondon, 117-129.
89. Simondon, “Les encyclopédies et l’esprit encyclopédique,” 121ff.
90. Simondon, “Les encyclopédies et l’esprit encyclopédique,” 118 [Translation J.F.M. Schick].
91. Simondon, “Les encyclopédies et l’esprit encyclopédique,” 129.
92. I follow here Jean-Hugues Barthélémy who claims that Simondon’s rendition of the encyclopedic spirit offers a theorization and justification of interdisciplinarity: “L’encyclopédisme, tel du moins qu’on peut le refonder aujourd’hui à la suite du philosophe français Gilbert Simondon, possède une vertu majeure : il pratique l’interdisciplinarité par le biais d’une unification philosophique des sciences, tout en offrant les premiers éléments d’une nouvelle et véritable théorisation de l’interdisciplinarité dans ses fondements, et donc dans ce qui peut la justifier.” Jean-Hugues Barthélémy, “Encyclopédisme et théorie de l’interdisciplinarité” *Hermès, La Revue: Interdisciplinarité: entre disciplines et indisciplines* 2013/3 Nr. 67, Paris: C.N.R.S. Editions, 165.

93. Paul-Antoine Miquel, *Le vital. Aspects physiques, aspects métaphysiques*. Paris: Kimé, 2011.

94. I will restrict myself to the epistemological aspects of the works of Bergson, Bachelard and Simondon. I will therefore not discuss “imagination” and the poetics of Bachelard, although, as for instance Jean-Jacques Wunenburger points out, both sides, the epistemological and the poetic side of the human mind are for Bachelard part of an integral anthropology (Jean-Jacques Wunenburger, “Bachelard, une anthropologie de l’homme integral,” in: *Altre modernità. Rivista di studi letterali e culturali*, Milano, Università degli Studi di Milano, 2012). I follow, however, Francesca Bonicalzi, who stresses the “point vélique” in Bachelard’s work to argue for the ethical and anthropological consequences of Bachelard’s epistemology of openness (Francesca Bonicalzi, “Gaston Bachelard: épistémologie ouverte et éthique de la connaissance” *Gaston Bachelard: Science et poétique une nouvelle éthique?* Jean-Jacques Wunenburger (ed.) Paris: Éditions Hermann, 13). I am aware that my account of an interdisciplinary anthropology cannot be comprehensive, since I limit myself to specific aspects of the aforementioned philosophers. An excuse, even if it is a weak one, might be that interdisciplinarity is always a practice that has to be created in a concrete situation.

95. I argue that interdisciplinary anthropology, as I have presented it, also subverts the classical oppositions between nature and culture as well as nature and technology. Jean-Hugues Barthélémy presents a similar argument, but is far more critical of “anthropology”: Jean-Hugues Barthélémy, “What New Humanism Today?” *Cultural Politics* 1, 2010; 6 (2), 245.