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# Invention and capture: a critique of simondon

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**ABSTRACT**
The evolution of technical objects is a central theme in Simondon's book *On the Mode of Existence of Technical Objects*. He describes it as though it were a natural process akin to the evolution of living beings; yet technical objects are *invented* objects that necessarily relate to human beings. The process of invention is analysed in great detail as the accomplishment of a cycle of images in Simondon's lecture course 'Imagination et invention' (1965–66). However, while Simondon pays much attention to the internal logic of invention, he completely brackets off the socio-political and economic context. This essay will develop a critical perspective on Simondon's quasi-biological conception of technical evolution and his notion of technical invention. To this end, I will draw arguments from Marx and the Marxist tradition that resonate with certain critical voices in the secondary literature on Simondon today. The goal of this essay is to show that technical invention is not an absolute and pure beginning that stimulates innovation and technical change, and to suggest an alternative and more complex view in which the pressure of economic drives and socio-political interests directly incite invention, especially where there is an institutionalised context that organises techno-scientific research.

## 1. Introduction

This essay will critically examine Gilbert Simondon's notions of technical evolution and invention that he elaborates in his book *On the Mode of Existence of Technical Objects* (2017 [1958]) and in his lecture course 'Imagination et invention' from 1965–66. While acknowledging his philosophical achievements and conceptual innovations, the aim of this essay is to point to some precise limitations of Simondon's thought, and to begin to outline a broader approach taking social, political and economic factors into account in which Simondon's insights may be situated.

In order to develop this argument the essay will first provide a summary overview of Simondon's general project, which is not simply a theory of technics but a philosophy of the integral system *human-technology-nature*, considered in its co-evolution and becoming. According to Simondon,

> it is thus the genesis of all technicity that needs to be understood, that of objects and that of non-objectified realities, and the entire genesis implicating man and the world, of which the

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> genesis of technicity is perhaps only a small part, shouldered and balanced by other geneses that are prior, posterior or contemporary, and correlative with that of technical objects. (Simondon 2017: 167)

In order to read Simondon today it is necessary to be aware of both the specific character of his genetic method and systemic aspiration, on the one hand, as well as of the way that his philosophy responded to the theoretical debates of his day by reflecting a particular evolutionary paradigm, on the other. It is precisely through the nature of this evolutionism that Simondon attempted to demarcate his project from the Marxist approaches that were prevalent around him. There is a consequent danger of focusing on those aspects of his largely optimistic and positive thought that resonate with our experience in today's highly technological world, while leaving aside the social, political and economic considerations that Simondon himself brackets. A certain amount of historical context helps to show the way in which this would overlook the inheritances of Simondon's work and thereby risk repeating, by a parallel exclusion, its preference for harmony (section 1).

After presenting some of Simondon's central concepts – the notion of technical evolution and the definition of technical objects (section 2) as well as his conception of invention, which draws its conceptual resources from the fields of Gestalt psychology, phenomenology and structuralism (section 3) – the fourth section will therefore develop a critical perspective that draws arguments from Marx and the Marxist tradition that resonate with some critical voices in the secondary literature on Simondon today. By way of conclusion, the last section will suggest a broader theoretical approach using a number of conceptual distinctions developed by Bertrand Gille, a French historian of technology. The goal will be to show that technical invention is not an absolute and pure beginning, based on the imperfections of technical objects that drive the process of technical evolution according to an intrinsic logic. Gille offers a more complex view according to which the pressure of economic needs and socio-political interests directly incite invention, especially where there exists an institutionalised context that organises techno-scientific research.

## 2. Simondon then and now

'The evolution of technical objects', Simondon writes, 'can only become progress insofar as these technical objects are free in their evolution and not pushed by necessity in the direction of a fatal hypertely' (Simondon 2017: 58). Here it is already possible to perceive some of the salient characteristics of Simondon's philosophy of technology, elaborated in his complementary doctoral thesis *On the Mode of Existence of Technical Objects*. First of all Simondon rejects an anthropological conception of technology that reduces technical objects to instruments or means in the service of human ends. Instead of a simple history of technology he postulates a genesis or evolution of technical objects with its own intrinsic logic and normativity. This quasi-biological description owes much to a line of thinking in his day that explained technics in continuation with life, as an extension of human organs or life processes. His teacher Georges Canguilhem, most notably, considered technical invention as 'a universal biological phenomenon and no longer simply as an intellectual operation to be carried out by man' (Canguilhem 1992: 63–4). Just as Canguilhem spoke of biological normativity, Simondon introduces the notion of technical normativity, referring to norms that technical reality itself establishes: 'the technical being thus exists as a germ of thought, concealing a normativity that extends well beyond itself' (Simondon 2013b: 342). This inherent normativity can only be understood and respected by someone with technical knowledge and a capacity for creation – Simondon's figure of the technician or inventor that he defines as a free individual (Simondon 2013b: 340) in opposition to the worker or the technocrat.

An important motive in Simondon's philosophy of technology is the idea of the 'liberation' of machines, which is evident in the quote that opens this section. While this may seem exaggerated to us, Simondon

> could rely on and refer to contemporary discourses that actually described automata and robots as 'mechanical slaves'. According to the cybernetically inspired techno-enthusiast Albert Ducrocq, for example, increasing exploitation of these slaves will contribute to solving, finally, basic human problems such as work, health, security, etc. (Schmidgen 2012: 21).

Simondon mentions Ducrocq critically as 'representing the technicist and technocratic tendencies' (Simondon 2017: 160) of cybernetic research in France. Simondon insists rather forcefully that 'the robot does not exist' and that it 'represents a purely mythical and imaginary being' (Simondon 2017: 16). He does of course not deny the existence of automatic machines, but for him 'automatism … is a rather low degree of technical perfection' (Simondon 2017: 17). Truly advanced technical objects possess a 'margin of indeterminacy' that allows them to be sensitive to outside information; they are able to adapt to changes in the milieu through circular causality. These self-regulating technical objects have a 'relative autonomy' (Simondon 2013b: 345) that makes them similar (though not identical) to living beings (Simondon 2017: 51). The mythical image of the robot, understood as a substitute for human beings, only betrays a cultural misconception of machines; and treating machines as 'slaves' simply conveys the unenlightened attitude that contributes to a cultural blockage of technical progress.[1]

Simondon therefore calls for a technical culture that would avoid those hypertelic phenomena that are unfavourable to technical evolution. Hypertelia, in the narrow sense, refers to the 'functional over-adaptation' (Simondon 2017: 53) of technical objects. Machines may be adjusted to very specialised circumstances and lose a degree of functionality, hence 'autonomy', outside their specific technical milieu. Hypertelic technical objects are 'closed objects', in that they do not lend themselves 'to being continued, completed, perfected, extended' (Simondon 2012: 13). Technical objects need to be 'open' to allow for a more flexible implementation and coupling with other machines and humans. While openness is an important technical value for Simondon, he also mentions the 'sincerity' of technical objects (Simondon 2012: 11), where this designates that the pure schemas of functioning are not obscured by inessential and obsolescent features. According to Simondon, cultural and economic factors can lead to hypertelic developments, for instance when cultural fantasies and economic desires motivate the construction of

[1]According to Schmidgen, Simondon's claim for a cultural blockage resonates with an argument put forward by Pierre-Maxime Schuhl, a French philosopher and professor at the Sorbonne after the Second World War, in his book *Machinisme et philosophie* from 1938 (republished 1947). Schuhl argues that slavery in ancient Greek societies functioned as an obstacle for developing and improving on existing technologies, since manual labour existed in abundance and was ready at hand at low cost. Slavery thus acted as a 'mental blockage' preventing further technical invention (Schmidgen 2012: 21–2).

transatlantic steamers that resemble ‘a fake floating city rather than an instrument of travel’ (Simondon 2012: 12). Pleading for a sort of asceticism, Simondon argues that ‘the cargo ship is more pure’ (12). Simondon can thus appropriately be called a ‘purist’ with respect to technology and an apologist for technical progress.

Simondon’s philosophy of technology was not received particularly well by the intellectual scene in France in the 1950s. This was a scene polarised by Cold War alliances, and it appears that Simondon tried to avoid as much as possible participating in the battle of positions. His critical remarks on capital are rather hidden: without explicitly referring to capitalism, he criticises a ‘civilisation of returns’ (*civilisation du rendement*; Simondon 2013b: 355) for enslaving the human and the machine. He explains this by monetary avarice, however, instead of economic imperatives; and the constraining character of such a civilisation manifests itself in restricting the mutual development of human and machine. Yet the worker must not revolt against the machine (Simondon 2013b: 355). For Simondon, workers’ uprisings and machine-breaking are a symptom of their technical alienation rather than an attempt to redress their socioeconomic oppression; such alienation resides simply in the fact that machines no longer prolong their sensory-motor capacities and gestures. Although he acknowledges the Marxist concept of alienation, he reduces it to a loss of private ownership that appears as a legal fact and maintains a more profound psycho-physiological alienation of the worker in relation to the machine. The French philosopher and sociologist Georges Friedmann, who was influential in making Marx’s earlier philosophical texts known in France, made the same argument at the time Simondon was writing, also ‘insisting on the presence of such alienation in the communist countries themselves’ (Barthélémy 2012: 203).

While Simondon’s aim is to raise ‘awareness of the nature of machines, of their mutual relations and of their relations with man, and of the values implied in these relations’ (Simondon 2017: 19), he shows no ambition to criticise the social relations of domination, in stark contrast to the Marxist intelligentsia around him. According to Pascal Chabot, ‘it was an act of daring to defend such a position among the intellectuals of 1950s France’ (Chabot 2003: 41), and perhaps goes some way to explaining why his work did not have much impact at the time. Chabot excuses ‘the extreme difficulty and even “unrealism” of this position’ (Chabot 2003: 42) as a sort of ‘prophecy’: Simondon ‘envisaged a system in which communism and capitalism would both be outmoded’ (Chabot 2003: 43). ‘In this vision of the future, technology is respected; humans have learned how to “communicate well” with technology: that is, to communicate on its level and not theirs’ (Chabot 2003: 43). Muriel Combes argues that Simondon’s reduction of the Marxian point of view to economism was a strategic move ‘in order to formulate his hypothesis of a more general alienation than the one situated on the economic level’ (Combes 2013: 74); but ‘at the very moment he critiques Marx, Simondon is far closer to him than he thinks’ (Combes 2013: 73). Joe Hughes is more explicit in casting doubt on Simondon’s reading of Marx and points to the potentially severe consequences: Simondon’s very neglect of socio-economic processes of production would itself ‘call into question the autonomy of technical evolution as developmental line comprising specifically technical norms rather than cultural and economic norms’ (Hughes 2014). The most pointed critique is perhaps to be found in Alberto Toscano’s work on Simondon, a position continued in this essay; this will be given more attention below, in the context of a more detailed discussion of the Simondon-Marx nexus (section 4).

While there clearly are critical voices in the Simondon scholarship, these may tend to get lost in a contemporary enthusiasm for Simondon. What has aroused particular interest is Simondon's reference to 'technical ensembles' or networks of 'open machines' that 'exchange information with one another via the intermediary of the coordinator that is the human interpreter' (Simondon 2017: 18). According to Erich Hörl, this can be seen as anticipating 'a new and now unavoidable "transcendental technicity" that underlies all experience in today's technical world which is based on computational networks' (Hörl 2015: 3). We are immersed in 'a network environment which is saturated or indeed inundated with various technological object cultures, which is characterised by hyperconnectivity and an explosion of complexity' (Hörl 2015: 7–8). Another characteristic of this new technical environment is that it is almost invisible and yet ubiquitous: it fades into the background of the 'ready-to-hand' and weaves itself into the fabric of everyday life (Weiser, cited in Hörl 2015: 9), and enables a constant communication and exchange of information that is imperceptible and unintelligible to human sensory and cognitive capacities. It should be noted that, for Simondon, the human subject continues to play an irreducible role:

> the functioning of a machine has no sense, and cannot give rise to true information signals for another machine; a living being is required as mediator in order to interpret a given functioning in terms of information, and in order to convert it into the forms for another machine. Man understands machines; for there to be a true technical ensemble man has to play a functional role between machines rather than above them. (Simondon 2017: 150)

For Hörl, Simondon's appeal to the technician as an 'associate' of machines (Simondon 2917: 139) is far too 'emphatic [and] actor-centered' (Hörl 2015: 6); it needs to be replaced by 'a new non-intentional, distributed, technological subjectivity that is informed by machinic processes and speeds' (Hörl 2015: 4), in short, a distributed 'ecotechnological subjectivity' (Hörl 2015: 6). What Hörl thus describes as 'the transcendental technicity of an ecotechnological process culture' (Hörl 2015: 9–10) resonates with many other theoretical avenues today, in particular with so-called 'flat ontologies',[2] actor-network theory, object-oriented ontologies and new materialism. It is not that such theories were influenced by Simondon, but that the current climate of distributed thought, of 'deleveling', to take up Brassier's term, provides fertile ground for a particular reading of his work, one that celebrates the apparently self-sufficient, intrinsic aspect of technological functioning. At the limit, this pure functioning comes to stand in for the logic of the social-natural whole itself, since one can no longer distinguish between human and machine, subject and object, in a network of 'transcendental technicity'.

When Simondon called for 'a voluntary push towards the development of technical networks, which are post-industrial and thus recover a continuous level [of operation]' (Simondon 2012: 12), his hopes were rather for an ultimate 'harmony or, more precisely, resonance between nature, humans and human technology' (Chabot 2003: 4). One can begin to reconstruct the inspiration for his thought by noticing that information technologies establish technical networks with 'terminal points', that is, stations for receiving and emitting information. These are distributed over the globe and throughout the human world, spilling over national borders. Thus reticular technical structures, the ideal case

[2]See Brassier (2015) for a critique.

of which is the information network, reconstitute a functional equivalent to the magical universe that Simondon proposes as the originary phase in a differentiated, multifaceted becoming. The magical universe likewise marks the key spatio-temporal points or singularities of the geographical and human world. The aim, for Simondon, is ultimately to recover or reconstitute a kind of magical unity that reconciles the human with the world in all its various modes of being – technical, religious, aesthetic, scientific, ethical, social and political. The task of philosophy, in turn, would be nothing less than to make these various modes converge in thought and establish an objective mediation between them through the propagation of a new technological culture.

## 3. Technical evolution

As mentioned in the introductory section, Simondon deliberately refrains from speaking of technical development, instead using the term technical *evolution*, as though it were a sort of natural process, which Simondon at one point compares to Lamarck's description of the evolution of living beings (Simondon 2008: 173). However, Simondon does not simply equate technical objects with living beings: while living beings carry their evolutionary potential with them – they not only reproduce themselves but are able to act upon themselves and their milieu in such a way as to create favourable conditions of existence – technical objects are invented objects. As Simondon puts it in his book *L'Individuation à la lumière des notions de forme et d'information*, living beings are able to solve problems they encounter, that is, problems that they are *part* of, through *invention*, by modulating their internal structures in anticipation of possible solutions. 'The living being is agent and theatre of individuation' (Simondon 2013a: 29); it acts as much as it is acted upon. The individuation of a technical object can also be described as a possible solution to a technical problem, yet a necessary part of the process is the human being: human beings constitute a system *with* technical objects (Simondon 1959: 371). The coupling between humans and technics in the process of invention will be analysed in the next section. What matters here is the question as to why Simondon nonetheless speaks of technical evolution. Indeed, this is perhaps the most striking characteristic of his philosophy of technology: the idea of an evolution of technical objects tending toward an increasing, yet always relative and limited, autonomy, which is manifest in a technical object's internal coherence or auto-correlation of its elements. This tendency toward autonomy is the process that Simondon calls concretisation. This view can legitimately be considered a kind of naturalisation: as Simondon puts it, concrete technical objects 'prove the viability and stability of a certain structure that has the same status as a natural structure, even if it might be schematically different from all natural structures' (Simondon 2017: 50).

In contradistinction to the majority of histories of technology that proceed by a chronological presentation and juxtaposition of technical inventions without revealing their phylogenetic lineages, Simondon holds that the technical object is precisely 'that of which there is genesis' (Simondon 2017: 26). The individual technical object, for Simondon, is not simply a single, isolated entity but a definitive stage within a whole phylogenetic lineage, which is open to perfecting. A philosophy of technology must look at the mode of existence of technical objects from this genetic point of view, and not merely classify the diversity of technical objects according to categories of genera and species from the point of view of their practical usage. Simondon argues that the latter type of classification is illusory in that one and the same practical purpose can be accomplished by very different technical operations. Categorisation according to an identity of use obscures more important intrinsic differences; for instance, engines are all used for propulsion in vehicles, but steam engines, gasoline engines, jet engines, or engines powered by springs or weights (e.g., in toy cars) function very differently and derive from different phylogenetic lineages. In fact, 'there is a more genuine analogy between a spring engine and a bow or a cross-bow than between the spring engine and a steam engine' (Simondon 2017: 25). What interests Simondon are the structures and functional schemas that are at the core of technical objects and make up their 'essence' (Simondon 2017: xvii, passim). Technical individuation is a process of concretisation, which is to say that the phylogenetic series of technical objects goes from abstract to ever more concrete technical objects. This genesis of technical objects is not just chronological: there is a logic to it, imbued with an 'internal necessity' (Simondon 2017: 29).

Let us consider Simondon's example of electronic vacuum tubes: a vacuum tube is a device in which an electric current flows between electrodes within a vacuum. The simplest vacuum tube, the diode, contains a heated cathode, which emits electrons, and an anode, which captures the electrons, after they have passed through the vacuum tube. The current can flow in only one direction as a result of the thermoelectric effect; when the voltage polarity is reversed and the anode is negative, then no current can flow, as the anode is not heated. This asymmetrical conductance is a stable behaviour that occurs within the electric field. Simondon calls this fundamental physical phenomenon a 'technical essence' or 'pure schema of functioning' (Simondon 2017: 45); it is an 'absolute beginning' (44) for a whole family of technical objects – the diode, followed by the triode, tetrode and pentode.

What is important is that this phylogenetic lineage of vacuum tubes resulted from the resolutions of technical problems, which tend toward the simultaneous creation of 'superabundant functions' (*fonctions surabondantes*) (Simondon 2008: 171), that is, new properties that permit a further 'perfecting' of the object that was not part of the fabricating intention. The addition of a control grid between the two electrodes, for instance, made it possible to regulate the current traversing the tube in a continuous manner without varying the anode-cathode voltage. This was the invention of the triode, in which there are now three separate parts for different functions: the cathode for producing electrons, the anode for capturing them, and a grid for regulating the electron flow from cathode to anode. The triode's functioning, however, was constrained by an undesired side-effect of auto-oscillation of the current in the tube. To solve this problem, another grid was added between the control grid and the anode, which functioned as electrostatic insulation; the extra grid not only solved the problem of auto-oscillation, but also had an amplifying function. According to Simondon, this convergence of functions in one element, i.e., the insulating grid, renders the tetrode a more *concrete* object than previous vacuum tubes – it has greater internal coherence, which is only surpassed by the pentode (Simondon 2008: 172).

The successive improvements of the vacuum tube can thus be seen as a process of concretisation – a progress that can best be observed in technical objects of the industrial or post-industrial age. 'Artisanal production corresponds to the primitive stage of the evolution of the technical object, i.e., to the abstract stage; industry corresponds to the concrete stage' (Simondon 2017: 29). As Simondon explains, the dominant criterion of the pre-industrial technical object is its *adaptation* to the external milieu and operator: 'its norms are derived from the outside: it has not yet realised its internal coherence; it is not a system of the necessary; it corresponds to an open system of requirements' (Simondon 2017: 29). An appropriate example would be what Marx says about the specialisation of tools in manufacture: tools are given a determined fixed shape, perfectly adapted to a particular function in the hands of a specific kind of worker.

> In Birmingham alone 500 varieties of hammer are produced, and not only is each one adapted to a particular process, but several varieties often serve exclusively for the different operations in the same process. The manufacturing period simplifies, improves and multiplies the implements of labour by adapting them to the exclusive and special functions of each kind of worker. (Marx 1977: 460–61)

Thus pre-industrial technologies (such as simple tools) are primarily designed to satisfy requirements of adaptation, and over the course of time this adaptive function becomes more and more refined.

> In the confrontation between the coherence of technical work and the coherence of a system of the needs of utilization, it is the coherence of utilization that prevails, because the technical object that is made to measure is in fact an object without intrinsic measure. (Simondon 2017: 29)

However, in the industrial age the design of technical objects shifted from the requirements of adaptation to the structural and functional *auto-correlation* of the object's elements. Industrial technical objects are characterised through an internal auto-correlation of the components, which instead of fulfilling only one function frequently combine several. Simondon's preferred example is the Guimbal turbine in a hydroelectric power station: the turbine is contained in a water-pipe and coupled with a small electric generator in a casing, which is filled with oil under pressure. Both water and oil are plurifunctional: the water not only functions as an energy source but also as a cooling-system for the generator. The oil in the casing prevents water ingression, because the oil pressure is higher than the water pressure; at the same time, it also serves to grease the bearings. Such a plurifunctionality engenders the coherence of the technical object. Moreover, the Guimbal turbine not only adapts to a given natural milieu, but also shapes and integrates it into its semi-autonomous functioning: the turbine creates a techno-geographical milieu. Nature, according to Simondon, is recreated within the technical universe: it becomes a necessary supplement to the technical schemas of operation (Simondon 2008: 175).

This plurifunctionality and auto-correlation of components increase the viability and stability of the industrial machine and make it more concrete, which is why its mode of existence can be considered as 'analogous to that of natural spontaneously produced objects' (Simondon 2017: 50). Simondon concludes that 'during the industrial stage, the object achieves its coherence and it is the system of needs that is now less coherent than the system of the object; needs mold themselves onto the industrial technical object, which in turn acquires the power to shape a civilization' (Simondon 2017: 29). In such passages Simondon appears to regard the technical system as dominant, if not determinant, with regard to other domains (e.g., social, cultural, political and economic). He does not exactly deny the impact of socio-historical needs, or material and economic constraints, but he clearly considers them only as *extrinsic factors*. 'If technical objects do evolve toward a small number of specific types then this is by virtue of an internal necessity and not as a consequence of economic influences or practical requirements' (29). Such an evolutionary process in fact finds its optimal conditions in a domain with a certain disregard for costs: it is mostly 'the domains where technical constraints prevail over economic constraints (aviation, military equipment) that become the most active sites for progress' (31).[3] Hence extreme circumstances such as war produce the purest technical objects, which render their essence or 'technicity' visible (Simondon 2008: 167). 'Indeed, economic causes are not pure; they interfere with a diffuse network of motivations and preferences that attenuate or even reverse them (a taste for luxury, the user's desire for very apparent novelty, commercial propaganda)' (Simondon 2017: 31).

Simondon will distinguish an inner kernel of the technical object from its manifestation and expression: the latter refer to outer layers that may be the result of aesthetic considerations or consumer preferences. One of his examples of these external layers is the visible use of aluminium alloys in the manufacture of cars, for instance for on the dashboard, from 1925 onwards. The aluminium alloys had no necessary or specific function but were only a deliberate reminder of airplane manufacture, which relied heavily on aluminium (in the 1920s the first all-metal planes were fabricated using aluminium alloys). The use of aluminium alloys for the automobile dashboard was entirely aesthetic and hence detached from any intrinsic technical logic; according to Simondon, it was supposed to give the car a more aeronautical touch and the driver the feeling of being a 'pilot' (Simondon 2008: 166).

In his lecture course 'La résolution des problèmes', Simondon also talks about a 'social filter' (*le filtre social*) (Simondon 2005: 312), which can have retroactive effects on the design of technical objects and lead to a modification or re-adaptation to a new milieu. The introduction of technologies requires a favourable milieu and sometimes, when the geographic, social and economic conditions of a country or its culture are insufficient to support it, technologies can meet with strong rejection, such as protectionist policies or the closure of the market to foreign commerce. Bertrand Gille provides as an example the protectionist policies of France, which placed a tariff on British iron in 1821–22, in order to avoid competition from technically superior industries. In France, the iron industry was based on traditional methods for smelting using charcoal produced from wood; responding to the shortage of wood, the English iron industry had long since introduced a method of smelting iron ore with coke, thus using coal as fuel. This led to a stark difference in technical efficiency: 'After it had been in use for some time, the coke-burning blast furnace was capable of up to three times the yield of the wood-burning blast furnace' (Gille 1986: 629). However, the French were slow to adopt this new technique mostly because of the inaccessibility of natural coal deposits, an insufficient transport network, the lack of a trained labour force and industry leaders' reluctance to introduce foreign techniques for fear that these might soon lead to others that would overthrow current practices (Gille 1986: 29).

Simondon does not enter into discussion of the ways that social, economic and technical systems interact, which is indeed the main objective that Gille takes up in his extensive two-volume study *History of Techniques* (1986 [1978]). Simondon believes that he can

[3]However, one could argue that this 'prevalence' of the technical over the economic, which arises in a domain that is awash with money, precisely reflects the social and political interest invested in this technical activity, rather than a pure rationality of technical progress. It seems strange that Simondon feels justified in bracketing off the whole socio-political and economic context, particularly in the case of the aeronautical or military-industrial complex, which are so heavily invested with 'impure' interests.

neatly distinguish a purely technical system from external social, political and economic factors, and he conceives of technical evolution as a quasi-biological process governed by its own internal, necessary logic responding to purely technical problems. However, to narrow one's perspective to technical problems is to choose to leave the wider social, political and economic context out of the picture: the various factors that influence technological change. Imperatives of capital, simply to reduce production costs and raise profits, or socio-political 'needs' concerned with communication, security and defence – in each case one would have to engage in a detailed study – are just as important for determining the actual lineages of technical development. This argument will be further elaborated in Sections 5 and 6 of this essay.

## 4. Technical invention

As invented objects, technical objects necessarily relate in some way to human beings. But the inventor, for Simondon, is not an ingenious demiurge that creates *ex nihilo* through his own imaginative resources. Simondon describes the technical invention as a process that surpasses the individual psyche. First of all, in most cases, there is not one inventor but a succession of inventors that, if separated by time and space, communicate through already existing technical objects. These technical objects, detachable as they are from the space and time of their creation, support what Simondon will call relations of cumulative participation (Simondon 2008: 163). What seem to be necessary prerequisites for invention are a selection of pre-existing technical objects from which one can extract elements or schemas of functioning, scientific knowledge of natural (physical, chemical or electric) effects, as well as suitable materials. Last but not least, for Simondon, what is required is the awareness of a problem to be solved. The most difficult and paradoxical part in the process of invention is that it demands a kind of 'vision' that represents a state that does not yet exist and in which the problem is solved. This field of finality, as he calls it, is in tension with the actual field of experience, which is characterised through incompatibilities between the system's sub-ensembles, a lack of functioning. According to Simondon,

> *the play of limits, whose overcoming constitutes progress, resides in the incompatibilities that arise from the progressive saturation of the system of sub-ensembles*; yet because of its very nature, this overcoming can occur only as a leap, as a modification of the internal distribution of functions, a rearrangement of their system. (Simondon 2017: 32)

This leap is conceived as a reversed conditioning of time: 'thus what is at stake here is a conditioning of the present by the future, by that which is not yet' (Simondon 2017: 60). What sounds impossible, or at least paradoxical, becomes possible because the human being *qua* temporal being is part of the equation:

> To solve a problem is to be able to step over it, to be capable of recasting the forms that are given within the problem and in which it consists. The solution of real problems is a vital function presupposing a recurrent mode of action that cannot exist in the machine: the recurrence of the future with respect to the present, of the virtual with respect to the actual. There is no true virtuality in a machine; the machine cannot reform its forms in order to solve a problem. … The living thing has the capacity to modify itself according to the virtual: this capacity is the sense of time, which the machine does not have because it does not live. (Simondon 2017: 156–57 translation modified)

Human beings are capable of invention, because they are temporal beings. They are able to imagine finalities and to create an 'organisation of solidarity' (Simondon 2017: 120), in which all the sub-ensembles converge in the coherent functioning of the system. But not everything depends on the imagination and 'creative force' (Simondon 2017: 120) of the inventor. In fact, there is an impersonal and materialist side to invention, the role of which cannot be known in advance; it concerns *circular causality*, the way that each step in problem-solving reacts back on the conditions of the problem. Circular causality, a concept that Simondon borrows from cybernetic discourse, refers to the feedback effects between the materials and the milieu. The inventor takes part in this feedback loop: his anticipation of the final state only evolves in communication with the materials, the chemical reactions and mechanical functioning of the component parts under his hands. There is a coupling between the inventor, the technical object and its associated milieu: they form a system, inventor-object-milieu.

Many interpreters overemphasise this impersonal and materialist conception of the invention, whereas Simondon is interested in a more psychologically informed account of inventive practice.[4] He draws additional inspiration from Gestalt psychology, in particular the schema of form and ground. According to Simondon, psychic life emerges from the imbrication of form and ground: forms of thought are

> clear, separate structures, such as representations, images, certain memories, and certain perceptions. All these elements, however, participate in a ground that gives them a direction, a homeostatic unity, and which acts as a vehicle for informed energy from one to the other and among all of them. … Without the ground of thought, there would be no thinking being, but rather an unrelated series of discontinuous representations. (Simondon 2017: 62)

Simondon explains that 'the ground is the system of virtualities, of potentials, of forces that carve out their path, whereas forms are the system of actuality' (61). He admits that it is 'very difficult to shed light on the modalities according to which a system of forms can participate in a ground of virtualities' (61), and in *On the Mode of Existence of Technical Objects* he does not pursue this inquiry any further. However, a couple of years later, in his lecture course 'Imagination et invention' from 1965–66, Simondon undertakes another, much more detailed attempt to analyse invention. At the centre of his reflection is the concept of the *image*, by which he means not merely mental images but also materialised images, or image-objects. His conceptual resources are taken primarily from phenomenology (the concept of 'body image' or 'body schema', i.e., the inter-sensory or the sensorimotor unity of the body)[5] as well as from structuralism (a theory of symbolic function, the Lacanian notion of *imago*).[6] Drawing from these resources, Simondon elaborates his own

[4]For instance, in *Technics and Time*, volume 1, Bernard Stiegler points to 'an inventiveness *that comes from the technical object itself*' (Stiegler 1998: 67). 'The technical object's potential of inventiveness' (75) is due to its coherent nature: it is a system in which a multitude of reciprocal causalities exist independent of any fabricating intention. 'The human has no longer the inventive role but that of an operator. If he or she keeps the inventor's role, it is *qua* an actor listening to cues from the object itself, reading from the text of matter' (75).

[5]Important influences on Simondon's theory of the image are Maurice Merleau-Ponty but also Jean-Paul Sartre and Gaston Bachelard.

[6]This notion of 'imago' refers back to an early text written by Lacan: 'Les complexes familiaux' from 1938. As Andrea Bardin explains, Simondon in his lecture course at the University of Lyon follows his colleague, the Lacanian Juliette Favez-Boutonier, who gave the course on imagination, a compulsory part of the curriculum for psychology students, in the years 1962–1963. According to Bardin, Simondon 'borrows and uses the Lacanian notion of *imago* precisely to understand the transition from the mental image to the object-symbol, a transition in which "the imaginary" would emerge as an "organised world" of symbol-objects, the status of which is *both* individual *and* collective (in Simondon's words

theory of the image, which he mixes with the dynamic or energetic model of evolution that was already in place in his book on individuation.

'Images', in Simondon's sense, have a unique dynamic: they participate in a quasi-organic evolution, a so-called *cycle of images*.[7] This cycle begins from primitive images that are nothing but an organism's motor-tendencies in interaction with the external milieu (Simondon 2008: 3). A living being responds spontaneously to stimuli from the associated milieu by extending them in schemas of action. The first type of image emerges in this interval between external stimuli and endogenic activity: it is an anticipation of possible movements or motor responses – that is, a projection or anticipatory image that flows from the body schema (*schéma corporel*) of the living being (30, 41). These motor-images are situated on a biological, instinctive level when the problem is that of, for instance, distinguishing between prey and predator, sexual partner, or a young animal of the same species (22).

The second type of image belongs to the psychological domain[8] and consists in a living being's perceptive and cognitive engagements with the surroundings 'according to primary categories of valence and signification' (63). At this stage, the living being performs a synthesis of inter-sensory images, identifies objects, receives and selects information. Again, these perceptive-cognitive images are not simply passive mental entities but rather endowed with an amplifying character, extending into definite action. For Simondon, images are always an intermediate reality that inserts itself between the subject and the world: they are the hinges between the coupling of two systems (92).

Finally, the third type of image emerges from affective-emotive experiences, the content of which can become fixed in memory-images. These images are organised in a veritable 'world of the imaginary', which prepares access to the symbolic field (130). According to Simondon, an image-symbol arises from a succession of images that accumulate at two opposing poles (such as the good mother and the bad mother), while it is always the first image of the series, i.e., the one originally experienced, which is the most intense (123, 128). Because of these opposing tendencies, an image-symbol is always in a metastable state (like an oversaturated solution).

> The image-symbol condenses a contradictory experience. … [it] attaches the subject to those events of which it has a complex memory. It makes the subject dependent on these events, of which it conserves a real and representative fragment that is equivalent to the [originary] concrete object and the enveloping situations. Inversely, the symbol also gives access to the object in the sense that it is a means to resuscitate and reconstitute it, on the basis of traces. (124)

For Simondon, this internal tension of the image-symbol is an important condition for invention, since it forces the image-symbol to develop into action, which can occur

"transindividual")' (Bardin 2015: 150). Contrary to structuralism, Simondon thus refuses the clear distinction between image and symbol and declares that 'the *Imago* as a kind of organiser is already an elementary symbol' (Simondon 2008: 128). See Bardin (2015: 152).

[7]'Image-objects are practically organisms, or at least seeds able to reside and develop in the subject. They exist even outside the subject, across exchanges and activities of groups: they multiply, spread and reproduce themselves in a neotenic state, until they have the chance to be resumed and deployed in the imaginary stage, where they find themselves incorporated in a new invention' (Simondon 2008: 13). See also Simondon (2008: 18).

[8]Simondon hesitates to designate this second level as psychological (see Simondon 2008: 42), since he wants to avoid giving the impression that the psychological is somehow opposed to the biological and sensori-motor realm, which it rather presupposes and prolongs.

either directly in terms of the subject's attitudes and conduct (a detour from established paths), or through the recruitment or creation of objects (magical objects, artworks, technical objects), which are *analogues* of the original reality represented by the image (126).

Image-symbols, though still historically determined, have a high degree of universality, which is why they form the basis of culture. As Simondon puts it, they *formalise* an experience of interaction with others and the world (129). The formalisation of images not only facilitates communication but also supports the solution of problems, which is the case in invention: 'Invention, whether practical or symbolic (formalisation), is the result of an interaction between an actual field of finality and an accumulated field of experience' (162). Invention completes the cycle of images and it is all the more perfect when it produces a detachable image-object (artwork or technical object), which can be passed on and function as the point of departure for a new cycle of images and invention (138, 163).

Simondon's analysis of the cycle of images exceeds a general psychology and, as he himself suggests, could rather be given in terms of a 'praxeology' (191): a *praxis* of life and invention. He cites the definition of praxeology given by Alfred Espinas in an article entitled 'Les origines de la technologie' (1890): 'the science of the most universal forms and the highest principles of action in the ensemble of living beings'. The cycle of images, which finds its completion in techno-symbolic activity, attains a certain degree of universality insofar as its products (drawings, statues, monuments, tools, machines, language) come to structure whole communities or civilisations. In this sense, techno-symbolic activity surpasses the cycle of an individual's affective-emotive, perceptive and biological images, and blends with a universal tendency that is life: the auto-organisation and differentiation of living beings within their milieu. With this conception of a *cycle of images* Simondon tries to 'explain the "natural link" between symbols and the reality they emerge from' (Bardin 2015: 146), and thus to avoid a strict separation of biological, psychic and cultural systems. His goal is to connect technical invention to processes of symbolic production and to embed this technical-symbolic practice in a broader 'natural history'.

Simondon's lecture course 'Imagination et invention', which could only be sketched here in broad outline, deserves consideration because of the contribution of this unconventional theory of images to an explanatory model for the development of technical lineages, a contribution that resides in the 'relative exteriority' (Simondon 2008: 186) and independence of the images with respect to the subject as well as their force and capacity to produce reality (by means of a 'cumulative causality' or the process of invention).[9] However, in terms of a theory of technical invention it is incomplete, enclosing the inventor in a sort of panpsychological world of images and symbols. Social or economic factors can only enter the imaginary-symbolic field by way of anticipations, norms, desires, fears and hopes – as an intermediate reality itself gathered into images.[10] While

[9]In his preface to Simondon's *L'Invention dans les techniques*, Jean-Yves Chateau surmises that imagination, for Simondon, is not simply a faculty of images but a genetic power (*puissance génétique*) or a dynamic ground (*fond*) that animates and engenders forms. With regard to *On the Mode of Existence of Technical Objects*, 'it will be noted that it is a psychological theory, original and elaborate, which makes it possible to account for the becoming-object of the mental schemata of inventing thought, and which renders the invented object homogeneous by genesis (and not only by analogy) to the thought and the images from which it is born' (Chateau 2005: 64, n28). He goes on to note that the lecture course 'Imagination et Invention' develops a very similar theory. There is a genetic dynamism of the image: the cycle of images leads to invention.

[10]'In fact, the image as intermediate reality between the abstract and the concrete, subject and world, is not only mental: it materialises, becomes institution, product, abundance and is distributed by means of commercial networks and the "mass media", which circulate information. Due to its intermediate character – fact of consciousness as well as object – it has a

Simondon's lecture course was designed for an audience of psychology students, it seems to follow a genetic line that puts the figure of the inventor as a 'lone individual' in the centre of his thought.

In the *Note complémentaire*, which was written in 1958 between his two theses and published posthumously in the 1989 edition of *L'Individuation psychique et collective*, Simondon refers to the inventor, or in this case the technician, as a 'pure individual' (Simondon 2013b: 339) who is able to disengage from the community and enter into a direct dialogue with the object and the world. According to Simondon, this had already been true for the ancient Greek city-states, whose high level of culture (the 'Greek miracle', Simondon 2013b: 340) was achieved thanks to the free reflexive thought and liberated activity of the technician:

> Thales, Anaximander, Anaximenes, are above all technicians. It should not be forgotten that the first appearance of free individual thought and disinterested reflection is the work of technicians, that is, men who have managed to free themselves from the community through direct dialogue with the world. (Simondon 2013b: 339–40)

Today, Simondon writes, true technical activity is found in the field of science: 'Free individuals are those who carry out research, and thereby establish a non-social relation with the object' (Simondon 2013b: 340). One has to wonder if this image of free scientific research is fictitious. Bertrand Gille, in this vein, counterposes:

> In fact, whatever the period, and at whatever level one chooses to place the liberty of the inventor, it is always severely circumscribed by the needs that the invention is designed to meet. The inventor is constrained by choice, then and this range of choice is limited (the choice of possible channels for nuclear power, or of processes which can be used in colour television, for example), and furthermore, the timing of inventions depends largely upon scientific and technical progress, and on economic necessity, etc. (Gille 1986: 40).

In one of the few interviews that Simondon gave in his life he revealed that his philosophy of technology was greatly inspired by the futuristic nineteenth century novels of Jules Vernes. Chabot comments, on this point, that 'Nemo's defiance is legendary. His quest is one of non-participation in the society from which technology shields him, propelled beneath the oceanic depths that envelop him in silence. Simondon is another of these explorers of limits – these indefatigable, uncompromising purists' (Chabot 2003: 121). Simondon's ideal of society is that of 'a society of individual creators of technical beings' (Simondon 2013b: 342) that are bound together through the intermediary of technical objects. 'Human beings communicate through what they invent' (Simondon 2017: 252). This society of psychic, technical and collective individuals produced by technical activity is what Simondon would call a 'transindividual' collective. Perhaps his conception of technical transindividuality can serve as an ideal for individuals and groups, but it cannot escape the broader framework of social relations.

## 5. Capitalist capture

Simondon understands technical reality as a mediation between human beings and nature (their milieu). By means of technical objects, human beings alter the conditions they find

high capacity to spread. Images pervade civilisations and imbue them with their force. In a way, images express social and economic facts' (Simondon 2008: 13).

themselves in and solve existing problems. Concrete technical objects have the advantage that they incorporate nature into their functioning and reinforce natural effects in a way that could not have been anticipated in the fabricating intention. This ‘functional surplus-value’ (*plus-value fonctionnelle*) (Simondon 2008: 174) generates what Simondon in his lecture course ‘Imagination et invention’ considers to be an amplifying ‘dialectical evolution’ (176) of the human-nature relation. He uses Marxist terminology here in explicit contradistinction to Marx, thereby attempting to demarcate his own approach. The political-economic context does not enter in any meaningful way into Simondon’s image of natural evolution. This becomes obvious, for instance, when he says:

> the mechanism of economic surplus-value that Marx describes in *Capital* expresses in the world of human labour one of the consequences of the introduction of technical inventions that permitted the industrial revolution; this meant that the work of the operators was incorporated in the schema of invention and recruited as natural effect. But the amplifying effect does not limit itself to the domain of the operators’ work … The amplifying dialectical evolution is neither human, social nor political; it [rather] characterises the whole domain of created and invented objects, not simply in their relation with human society, but also in their relation to nature. Through the intermediary of created objects, the human-nature relation is subject to a process of amplifying dialectical evolution, the active foundation of which is invention. (Simondon 2008: 176)

In general, Simondon appears to ascribe to Marx a version of technological determinism which, despite the widespread caricature, does not seem to be accurate.[11] He also neutralises Marx’s critique of political economy, which is aimed at the level of a mode of production as a whole, and in which technical considerations are only one aspect of the social situation. More specifically, Simondon overlooks Marx’s detailed analysis (in Part Four of *Capital*, ‘The Production of Relative Surplus Value’) of how the process of technical development is overdetermined by the valorisation process, particularly the accelerating pursuit of relative surplus value, a genetic principle in Marx that Simondon misrecognises as the simple effect of a ‘functional surplus-value’. While Simondon talks about the introduction of industrial machinery as an amplifying dialectical process in the human-nature relation, this appears as the progressive solving of problems only in abstraction from the social field. Moreover, it requires that we set aside the fact that the specific problem the introduction of this machinery was designed to solve was not at all technical in nature, but that of increasing the amount of value that could be extracted from a given quantity of labour time.

Marx, for his part, makes it clear that new technologies may contribute to the worsening of the problems provoking their introduction; the pursuit of relative surplus value is itself a feedback loop. They may also be inherently inimical to their operators, not just accidentally, or as a result of interfering factors. One could indeed elaborate a different theory of technical invention and development from the Marxist perspective:

> Machinery does not just act as a superior competitor to the worker, always on the point of making him superfluous. It is a power inimical to him, and capital proclaims this fact loudly and deliberately, as well as making use of it. It is the most powerful weapon for suppressing

[11]Those that argue for technological determinism find their confirmation in Marx’s famous statement that ‘the hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist’ (*The Poverty of Philosophy*, chapter 2, available at the Marxists Internet Archive, www.marxists.org). However, this early text is a substantial reduction of Marx’s overall project for a critique of political economy, in particular his analysis of the capitalist logic of valorisation.

> strikes, those periodic revolts of the working class against the autocracy of capital. According to Gaskell, the steam-engine was from the very first an antagonist of 'human power', an antagonist that enabled the capitalists to tread underfoot the growing demands of the workers, which threatened to drive the infant factory system into crisis. It would be possible to write a whole history of the inventions made since 1830 for the sole purpose of providing capital with weapons against working-class revolt. We would mention, above all, the self-acting mule, because it opened up a new epoch in the automatic system. (Marx 1977: 562–63)

The self-acting mule that Marx mentions was an automated spinning machine, which was operated by a person called the minder and two boys called, respectively, the side piecer and the little piecer. The piecers' job was to repair sporadic yarn breakages while the mule was in full motion and to clean the machine, which was a particularly dangerous operation. It involved running bent under the yarn sheet twice the whole length of the mule, without touching the sheet, and it was a common accident in those days that boys were crushed by the machine. Needless to say, the spinning mule was designed in such a way that only children, because of their small size, could perform the cleaning ritual.

It requires only a little attention to such examples to perceive that the reality of the industrial world from the point of view of the workers' experience was far from Simondon's image of the human-machine relation. To be sure, Simondon criticises the model of work that he finds to be intrinsically alienating and sets against it a notion of liberating technical activity: 'the relation of the worker to the machine is inadequate, because the worker operates on the machine without his gesture continuing the activity of invention in this gesture' (Simondon 2017: 254). However, he insists that 'the industrial grouping is not the only one that can be brought about (*réalisé*) with technical objects: non-productive groupings can also be brought about, whose end is to relate man and nature through an ordered succession (*enchaînement réglé*) of organised mediations, to create a coupling between human thought and nature' (Simondon 2017: 251). What is really missing from Simondon's reflections here is an awareness of the social and economic factors that shaped the reality of the industrial world. It is possible to specify quite precisely the way in which (1) economic needs and (2) class interests overdetermine the development of industrial machinery.

(1) Marx was the first to analyse in detail structural alienation under capital. The worker is not simply subject to the machine but to the technologically-embodied rationality of the productive process itself, i.e., the logic of capital. Marx shows how this logic set the stage for the introduction in the first half of the nineteenth century of large-scale industrial machinery and more efficient organisational techniques: the prolongation of the working day, the intensification of labour, the imposition of a rigid spatio-temporal, disciplinary regime of work, the worker's life-long dependence on a machine, and the production of a surplus population (systemic unemployment). Industrial machinery is not just deeply embedded in the capitalist process, but a kind of natural outgrowth of a drive to accumulate that must continually call forth, from out of the future, solutions to the problems posed by competition and falling profit rates. Thus, as Gille emphasises, 'economic needs – expressed in problems of quantity and cost – are just as important' for technological development. 'Most of these needs

are usually divided roughly into three categories: to produce the same quantity at a lower cost, or a greater quantity at the same cost, or to produce a greater quantity at a lower cost' (Gille 1986: 38–39).

(2) As Marx argues in the quote cited above, the introduction of machinery in the factory system can also be analysed in terms of an effective means to supress strikes. Inventions, irrespective of whether this was part of the fabricating intention or not, can serve as 'weapons against working-class revolt'. Cornelius Castoriadis has pointed out the importance of social conflict and class struggle within a capitalist enterprise very clearly:

> The fact is that the development of capitalist technology and its application to production have, since very early times, been oriented in a well-defined direction – towards the greatest possible elimination of the producers from the process of production. Whether the price of labour is high or low, those in control of a capitalist firm will always choose, if they have the opportunity, the process which ensures the greatest independence of the production process in relation to the workers. They want to depend, not on men, but on machines: such is the defence which the management adopts (or the preventive measure which it takes) when faced with the workers' struggle over speed, quality, or conditions of work. (Castoriadis 1984: 251)

When Simondon talks about the replacement of workers by the machine (or the 'technical individual'), he still considers it as a phase in technical evolution. It is a 'change in relation between the technical object and the human being: the factory is a technical ensemble that is comprised of automatic machines, whose activity is parallel to that of human activity; the factory uses true technical individuals, whereas, in the workshop, it is man who lends his individuality to the accomplishment of technical actions' (Simondon 2017: 131). According to Simondon, the frustration that the worker experiences in the factory setting does not so much depend on the property relations and general impoverishment that Marx critiques – the fact that the worker does not own the means of production and cannot produce what he needs but is forced to sell his time as a vital element in the valorisation process. Rather the frustration is due to 'an even more profound relation'

> at the physiological and psychological level of the individual properly speaking. The alienation of man in relation to the machine does not only have a socio-economic sense; it also has a physio-psychological sense; the machine no longer prolongs the corporeal schema, neither for workers, nor for those who possess the machines (133).

While in the artisanal age, tools and instruments served as an extension of organic function – an idea that is already expressed by Bergson, detailed in the work of Leroi-Gourhan and taken up by Canguilhem – technics in the industrial age can no longer be described in terms of a 'general organology'.

What Simondon criticises is thus an incompatibility between physiological, psychological and technical individuation, and he seeks the solution in a 'mechanology' (Simondon 2017: 50), a more fortunate or harmonious coupling between humans and self-regulating machines, since 'self-regulating machines need man as a technician, which is to say as an associate' (139). Simondon seems to have imagined a possible emancipation in the form of a good coupling of humans and machines that could be achieved 'through the establishment of a common symbolism': 'it is because of this symbolism that a synergy between man and machine is possible; for common action requires a means of communication' (117). Simondon envisions human beings as one link within a kind of cybernetic machinic ensemble, which functions as the vehicle for action and information. The human being intervenes as the one who has an understanding of the machine, is able to translate forms into information and to take care of the integration of elements in the functional ensemble.

In the end, however, Simondon's utopian vision of technical invention cannot evade capture by a subtending logic of *innovation*, that of capital. This is even less the case in the current appearance of cognitive capitalism, which celebrates the creativity and inventive capacity of the worker, in which so-called creative jobs have much more flexible space-times yet are no less oppressive, leading usually to a delimitation of working hours, or an indiscernibility between free time and working time. Moreover, they simply help to disguise the asymmetrical work relationship between employer and employee (Lordon 2014). Ultimately, as Alberto Toscano rightly argues,

> Simondon's strength – the manner in which he has been seen by some to anticipate the transformation of the social individual with the withering away of the national-industrial figure of the working subject – is also his weakness: by isolating a machinic and inventive option, and bracketing out the entire dimension of political economy, it becomes impossible for Simondon (and for those who might follow him) to think the external capture, or the immanent promotion, of invention and machinism in and by capital. For Simondon, the subsumption of technology is always merely formal, extrinsic, and never real or constitutive – so that he has no way to think the tendential indiscernibility between work, play and invention within capitalism. (Toscano 2009: 15)

Simondon's hope seems to have been the creation of a common language between humans and machines that would enable direct communication – a cybernetic idea that has in a certain sense become reality with the digital. The question, however, is whether, through an immersion of humans in the ubiquitous networks of information and communication technologies, we have come any closer to an equivalent to the magical unity that Simondon envisioned – or any closer to an emancipated and egalitarian mode of being, in more prosaic terms. Has this 'new dispositif of transformatory technologies' (Hörl 2015: 4) truly dissolved the working subject and freed a space for the creative individual, as has been proclaimed? It may rather be that a generalised network of transcendental technicity is the best metaphysical subtlety for making social relations appear in 'the fantastic form of a relation between technical objects', to paraphrase Marx's famous lines on the commodity fetish. Social relations of power, already very difficult to discern in Simondon's work, would become impossible to detect beneath the objective veneer of contemporary technics.

## 6. Conclusion

The question, at bottom, is whether or not one can think of technical invention in isolation as a disinterested techno-scientific practice, revealing a pure technical logic that is independent of the play of economic, social and political constraints. Gille suggests distinguishing

> between the progress of techniques, and technical progress, the first being of a purely technical order, in the sense that there are some inventions which are not immediately useful, but which can lead to 'innovations'. The second represents exactly the point at which the invention enters everyday or industrial life. It is thus possible to put invention on two planes: that

> of technical thought representing technique in its pure form, and that of economic need in the wider sense of the term, in order to respond to technical problems or to follow purely economic needs. The latter may be in the form of increased demand, in the need for reduction in production costs, etc., all factors more or less linked with each other (Gille 1986: x)

A crucial distinction implicated in the difference between 'progress of techniques' and 'technical progress' is thus the one between invention and innovation. A simple invention is in need of further developments, that is, a successive perfecting that facilitates its practical application without changing its fundamental schema of functioning. In order to be realised as an economic innovation, however, the invention also needs to make a certain leap toward becoming a predominant operation in the technical system. Not all inventions are useful and many of them are never realised, remaining pure virtualities. 'An invention is only feasible if it accords with an economic, social or other need, which is to say, when innovation is desirable' (Gille 1986: 60).

In his two-volume study of the history of techniques Gille comes to the conclusion that today invention is actually 'disappearing as a distinct entity' (63). Invention as an individual initiative becomes more and more impossible due to the amount of scientific knowledge and laboratory equipment required, and the rising costs of research. This is also why fundamental research has become institutionalised in official departments financed by state agencies (military, state universities, etc.) and large corporations (corporate research units and laboratories, adjunct foundations at universities, etc.).

> Formerly, invention had to wait for the favourable technical, economic and social conditions to arise in order to be applied. Innovation followed invention. Henceforth it will be the desire for innovation that brings forth invention: the schema is completely reversed (63).

This is not to say that there will be no more disinterested scientists approximating Simondon's ideal of the pure individual, but that today they are most often employed by corporations, the State or state agencies. According to Castoriadis:

> Archimedes' inventions during the siege of Syracuse constitute an exceptional and isolated fact, whereas it is quite typical that thousands of scientists should be employed by the Pentagon, and that when we read a study on animal psychology, linguistics or mathematics we should discover, on reaching the last page, that it has been 'financed by US Navy Project No. … (Castoriadis 1984: 247)

One thing that can be useful today, as Gille suggests (Gille 1986: 40), is to study the complex institutional contexts that foster fundamental research and direct the process of invention. Institutions also provide the context in which many technical and economic needs can first be expressed; they encourage technical development through a system of patenting, legal policies and subsidies, as well as the offering of prizes.

Ultimately, the real motor of technical invention is, for Gille, what he calls 'structural limits' (Gille 1986: 23): this could be, for instance, the integral limitations of a given technological lineage, limitations of raw materials, economic limitations, protectionist policies, tariff protection, and so on. As he explains, 'since all techniques are interdependent in any one system, it only needs one sector to reach its limit for the whole system to be blocked' (Gille 1986: 29). In this way a technical blockage can lead to the mutation of technical systems and precipitate progress. He thus recommends a precise historical study and comprehensive analysis of social, political and economic factors, in order to account for invention and technical progress effectively and universally. Research in this area would aid in understanding the objective and structural causes of technical change and thus supplement Simondon's notion of invention, since the latter responds to incompatibilities within a single technical object or technological lineage, and also relies on certain biopsychological and psycho-social processes, insofar as technical invention is considered as the final accomplishment of a cycle of images. Certainly, one difficulty in bringing these two thinkers into dialogue lies in the two distinct registers of description: within the framework of historical research, we encounter an explanation of empirical facts and intertwining factors (technical, economical, social and others), whereas in the case of Simondon, we are confronted with the integrity of an intrinsic logic. A synthesis of these different poles of a theory of invention remains to be worked out.

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