

## The solfège of technical objects: notes on the potential contribution of Gilbert Simondon to sound studies and arts

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### Abstract

The extended meaning of solfège in Pierre Schaeffer's theoretical and artistic work is briefly introduced. Then, Gilbert Simondon's philosophical ideas are summarised, and their potential contribution to the field of sound studies is discussed. Simondon's concepts of 'individuation', 'transduction', 'information', 'modulation' and others are presented, as well as his main critical analysis of the hylomorphic perspective. Simondon's attempt to seek a more congruous and well-balanced coupling between human and technical beings is corroborated, and this corroboration supports the contention that this approach to sonic practices demands a 'solfège of technical objects' that may have political and ethical consequences, as well as theoretical and artistic reverberations relative to how we deal with sounds.

### Keywords

solfège, technology, technical object, individuation, Gilbert Simondon

### Introduction

The perceptive processes and the very concept of what is related to the term *solfège* were deeply transformed by post-war music and sonic practices. This occurred due to the creative and theoretical reconsideration of *solfège* by Pierre Schaeffer (1996, pp. 490-508) and as a consequence of the development of techniques and *technical objects* that changed how we imagine, create, perform and listen to sounds and music.<sup>1</sup>

The post-war period also saw the development of new technological resources, such as studio equipment and the first digital computers, that had a growing impact on sound and music creation, production and diffusion. During this period, Gilbert Simondon wrote his works *L'individuation: à la lumière des notions de forme et d'information* (Simondon, 2005a) and *Du mode d'existence des objets techniques* (Simondon, 1989), both of which were published in 1958. In the first, Simondon presents a new philosophical framework to address the issue of *ontogenesis* through the concept of *individuation*, i.e. the process through which an *individual* originates and detaches itself from a surrounding environment. In the second, he develops the outcomes of these new concepts and casts new light on the question of technology by introducing his theoretical formulations of technical objects.

If the work on individuation can enrich sound studies by providing new conceptual formulations, such as 'dephasing', 'information', 'transduction', 'modulation' and other key terms to Simondon's thought, the thesis on the technical objects is of interest for broader reconsideration of musical practices that were redefined by Schaeffer's *solfège généralisé* and his *programme de la recherche musicale*. We imagine, listen, create and perform sounds and music through the mediation of technical objects and techniques.

The practices and approaches proposed by Schaeffer and other post-war composers and artists could only flourish and develop due to the concomitant development of new techniques, technical objects and technical ensembles, such as amplification, the microphone and the radio studio, respectively.

These new technical resources not only allow us to perform sound-related activities in new ways, they also require us to understand the technical particularities that shape our mediated interactions with sounds and our own imaginative and auditory faculties. As will be shown from Simondon's ideas, if on one hand these new technical objects enable us to have a completely new relationship with the creation and perception of music and sounds, on the other, they require a new dialogical interaction with their mechanisms and modes of operation. These tools, instruments, devices or machines reproduce, to a certain extent, the stereotyped human ideas, gestures and operations that are registered in their gears, technical parts and procedures. When using them, we not only deal with sounds but also with the preconceived ideas that we set in motion when we use these objects to mediate different actions, such as listening, composing and performing.

This article presents some of these Simondonian concepts and ideas and relates them to listening, imagination and creation practices summarised in the already extended meaning of the term *sofège* after Schaeffer. Particularly, this article aims to introduce Simondon's thought into the fields of sound arts and studies, and to outline the potential reconsideration of these practices, starting from the pursuit of an active interpretation of the technical objects that mediate our activities.

## Sofège

One of the reasons that Schaeffer gives to justify his *programme de la recherche musicale* and his project for *sofège experimental* is the diagnostics that, in various fields, such as music theory, education and composition, it was possible to identify the primacy of activities of sound production and fabrication according to certain types of 'schemes, notations or intentions', i.e. *thème*, at the expense of listening and the effort required to refine our perception of sounds, i.e. *version* (Chion, 1983, p. 90; Schaeffer, 1996, p. 147). Indeed, the main target of traditional *sofège* was not the perception and production of sound itself, but the music parameters that could be notated using the schematic symbols of music scores. Schaeffer's new generalised *sofège* offered methodical resources to develop 'the art of better listening', thereby inverting the unbalanced relation between *making* and *listening*. This was proposed by presenting conceptual and methodical tools to identify, describe, analyse and manipulate *sonic objects*. The Schaefferian *sofège* precisely aims to enable, among other things, the identification of individualised *sonic objects* by recognising the qualitative features that allow us to 'isolate them from the sound chain' (Chion, 1983, p. 35) and to enable the recognition of their morphological characteristics, thereby providing new concepts and parameters to describe them qualitatively (Chion, 1983, p. 113). This is done through *reduced listening*, which largely depends on the mediation of technical objects and the new sound handling techniques that they enable, notably 'cut bell' and 'locked groove', which are two primitive experiences that would later be developed in concepts such as *reduced listening* and *sonic object*.<sup>2</sup>

It is possible to relate Schaeffer's *sofège* to the two main topics that Simondon develops in his theses, i.e. *individuation* and *technology*.

In approaching *sofège* from the perspective of Simondon's theory of *individuation* and his philosophy of technology, what Schaeffer understands as a *sonic object* depends on both its *individuation* and *technical* mediation. The sounds of a bell or violin exist as individualised *sonic objects* from the moment they are perceived as being dynamically detached (*individuated*) from a background sound chain through a process called *transduction*, to use the philosopher's terminology. Simply put, a *sonic object* can be considered a *sonic individual* that originates and holds its individuality when it is not merged with other sonic objects or the underlying sonic environment. On the other hand, the recognition, description, analysis and manipulation of such objects depend on the mediation of specific *technical elements*, *technical objects*, *technical ensembles* and *techniques*. In fact, despite the focus on *listening* and the proposition of procedures and concepts to deal with sounds, this new *sofège* emerged and developed from direct manipulations and experimental interactions with the technical objects found in the studio. Using tools such as the turntable, mixer, and *phonogène*, or even by developing and applying specific idiosyncratic inventions, such as the *potentiomètre d'espace* (Manning, 2004, p. 26) Schaeffer had key insights for his theoretical and artistic work, e.g. as previously mentioned, with the 'cut bell' (Schaeffer, 1998, pp. 115-16).

To establish viable connections between these Simondonian concepts and the sound practices and studies that can be related to the term *sofège*, it is important to outline Simondon's main ideas.

### **Dephasing, information, transduction**

In his thesis on *individuation*, Simondon's perspective is preceded by a critique of *substantialist* and *hylomorphic* views.

"The reality of being as an individual may be approached in two ways: either via a substantialist path whereby being is considered as consistent in its unity, given to itself, founded upon itself, not created, resistant to that which it is not; or via a hylomorphic path, whereby the individual is considered to be created by the coming together of form and matter. The self-centered monism of substantialism is opposed to the bipolarity of the hylomorphic schema. However, there is something that these two approaches to the reality of the individual have in common: both presuppose the existence of a principle of individuation that is anterior to the individuation itself." (Simondon, 2005a, p. 23; 2009, p. 4).

Rather than taking the individual for granted, Simondon argues that we should attempt to understand the process of individuation and 'know the individual through the individuation, rather than the individuation through the individual' (Simondon, 2005a, p. 24; 2009, p. 5). He adds that the process of *individuation* results in the actual *individual* and also creates the 'individual-milieu' pair.

"Pre-individual being is being in which there is no phase; the being in which individuation occurs is that in which a resolution appears through the division of being into phases. This division of being into phases is becoming. Becoming is not a framework in which being exists, it is a dimension of being, a mode of resolution of an initial incompatibility that is rich in potentials. *Individuation corresponds to the appearance of phases in being that are the phases of being.*" (Simondon, 2005a, p. 25; 2009, p. 6).

Simondon's use of the word *phase* can be related to two slightly different meanings of this term in physics. When used to address the study of matter, materials and systems, *phase* can be defined as the 'homogeneous part of a heterogeneous system that is separated from other parts by a distinguishable boundary' (Rennie, 2015, p. 426). When used to describe oscillatory systems, the term *phase* acquires a dynamical and relational connotation, describing the

“stage that a periodic motion has reached, usually by comparison with another such motion of the same frequency. Two varying quantities are said to be in phase if their maximum and minimum values occur at the same instants; otherwise, there is said to be a phase difference.” (Rennie, 2015, p. 426).

Considering these two connotations of the term *phase*, an *individual* not only has a *different phase* regarding what surrounds it, but also has a *phase difference* compared to other dynamical processes that may occur nearby. In the first definition, an individual arises when it detaches from a background homogeneity with the clear emergence of 'a distinguishable boundary' between the *individual* and the *environment*. In the second definition, the dynamical process of individuation is characterised by a process in which the *individual* not only dissociates from a medium, but also becomes and stays *out of phase* in relation to surrounding objects, processes, substances, etc.

According to Simondon, the individual arises not from some sort of demiurgic association between a given passive *matter* and an equally abstract *form*. Rather, it emerges from the process of *allagmatic exchange* of energy (*transduction*) that informs the being 'from part to part' and in different orders of magnitude, i.e. from both inside and outside the edges of what will be the resulting individual. [3] From this perspective, rather than the notion of *form*, we should think about *individuation* in terms of *information*. However, such *information* is not conceived as the 'signals or to the supports or carriers of information in a message, as the technological theory of information tends to do' (Simondon, 2005a, p. 35; 2009, p. 12), rather it is *information* considered as the *momentum of individuation*, i.e. *information* demands the *dephasing* of a pre-individual being and its subsequent division into *individual* and *milieu*. *Information...*

“[...] is a *demand for individuation*, for the passage from a metastable system to a stable system; it is never a given thing. (...) Information can only be inherent to a problematic; it is *that by which the incompatibility of the non-resolved system becomes an organizing dimension in the resolution*; information supposes a *phase change of a system*, because it supposes an initial preindividual state that individuates itself according to the discovered organization. Information is the formula of individuation, a formula that cannot exist prior to this individuation.” (Simondon, 2005a, p. 31; 2009, p. 10).

If *information* can be understood as the *demand of individuation*, the process that propagates *information* and describes the dynamical process of *individuation* is referred to as *transduction*.

“By transduction we mean an operation – physical, biological, mental, social – by which an activity propagates itself from one element to the next, within a given domain, and founds this propagation on a structuration of the domain that is realised from place to place: each area of the constituted structure serves as the principle and the model for the next area, as a primer for its constitution, to

the extent that the modification expands progressively at the same time as the structuring operation. A crystal that, from a very small seed, grows and expands in all directions in its supersaturated mother liquid provides the most simple image of the transductive operation: each already constituted molecular layer serves as an organizing basis for the layer currently being formed. (...) Transduction can be a vital operation; it expresses, in particular, the direction of the organic individuation; it can be a psychic operation and an effective logical procedure, even though it is not limited to logical thought. In the domain of knowledge, it defines the veritable process of invention, which is neither inductive nor deductive, but transductive, which means that it corresponds to a discovery of the dimensions according to which a problematic can be defined. It is that which is valid in the analogical operation. This notion can be used to understand the different domains of individuation: it applies to all cases where an individuation occurs, expressing the genesis of a network of relations founded on being. (...) Transduction corresponds to this existence of relations that are born when the preindividual being individuates itself; it expresses individuation and allows it to be thought; it is therefore a notion that is both metaphysical and logical.” (Simondon, 2005a, p. 32; 2009, p. 11).

According to Simondon’s perspective, *transduction* is a process that occurs not only in chemical or physical operations, but also in biological, psychological and social dimensions, thereby driving the *individuation* process through the propagation of *information*.

Thus, the term *transduction* is not restricted to its connotation in acoustics and audio engineering as the process of transmission/conversion between different forms of energy through *transducers*, such as microphones, loudspeakers, etc. (Rossing, 2007, p. 761). Simondon’s perspective reconsiders these processes as not distinct from others that are at stake when, for instance, we are creating, listening to or interacting with sounds. The very recognition and delimitation of individual *sonic objects* can be related to a *transduction* process that occurs not so much during the mechanism of recording/reproduction, but, above all, in the perceptual and psychophysiological processes that enable us to detach these sounds from a continuum and identify, analyse and manipulate them individually using technical means.

### **Technical individuation**

Given that *individuation* and *transduction* are processes that can be investigated in multiple dimensions (physical, chemical, biological, psychological, social, etc.), they can also be applied to sound studies as a means to understand how we identify, qualify and deal with *individual sounds*. Furthermore, Simondon’s thought is particularly suggestive regarding the application of technical concepts, images and words to develop a theoretical perspective on *ontogenesis* and *individuation*.

In this sense, it is relevant that the very first paragraphs of his thesis on *individuation* refute the *hylomorphic* schema, not because it departs from a dualistic perspective on physics and technology—which, in principle, could explain how objects such as a brick or statue are produced by addressing their *formal* and *material causes*—but rather because this model is highly abstract and distant from actual technological mediation. It ignores the handicraft knowledge and work that result in real individual objects.

“The technological character of the origin of a model does not invalidate this model, with the condition that the operation which is used as a basis for the formation of the utilised concepts passes entirely and expresses itself without deterioration in the abstract model. If, on the contrary, the abstraction is carried out in an unfaithful and summary manner, by masking one of the fundamental dynamisms of the technical operation, the model is false. Instead of having a true paradigmatic value, it is nothing more than a comparison, a more or less rigorous juxtaposition according to the cases.

However, in the technical operation which gives rise to an object having form and matter, like a clay brick, the real dynamism of the operation is extremely far from being able to be represented by the matter-form couple.” (Simondon, 2005a, pp. 39-40; 2007a).

Taking brick production as an example, Simondon argues that both the mould and the clay cannot be reduced to the *hylomorphic* scheme. Both have properties that are carefully developed during their own technological production and whose *formal* and *material* functions are crucial to individuation of the brick through the manufacturing process. Nevertheless, the final brick is not the sum of *formal* and *material* dimensions. It is the *mediation* between two different technical elements: the clay and the mould. These two elements, as well as the energy that the artisan transfers to the clay, *inform* each part of the individual from different *orders of magnitude*.

What distinguishes Simondon’s view of *technical individuation* from the *hylomorphic* scheme is that, even in the case of an apparently still object, such as the brick, the process of individuation that underlies its manufacture is *dynamical*. Thus, it cannot be completely represented by the motionless image of the *hylomorphic* combination of matter and form.

This dynamical approach makes it possible to compare, as not essentially distinct, heterogeneous technological processes, such as the *moulding* of a brick and the electrical *modulation* of triodes.

“The difference between the two cases lies in the fact that, for the clay, the operation of taking form is finished in time: it tends, rather slowly (in a few seconds) towards a state of equilibrium, until the brick is taken from the mold; one uses the state of equilibrium while unmolding when it is reached. In the electron tube, one employs a support of energy (the cloud of electrons in a field) that presents a very weak inertia, so that the state of equilibrium (adequacy between the distribution of the electrons and the gradient of the electric field) is obtained in an extremely rapid time compared to the preceding (some billionths of a second in a tube of greater dimensions, some tenth of a billionth of a second in the smaller tubes). Under these conditions, the potential of the grid of order is used as a *variable mold*; the distribution of the support of energy according to this mold is so fast that it is carried out within the smallest minimum time for the majority of the applications: the variable mold is then used to vary in time the actualization of the potential energy of a source; one has stopped not when equilibrium is reached, one continues by modifying the mold, i.e., the grid voltage; actualization is almost instantaneous, there is no end to its release from the mold, because the circulation of the support of energy is equivalent to a *permanent release from the mold*; a modulator is a *continuous temporal mold*. (...) The mold and the modulator are extreme cases, but the essential operation of taking form is achieved there in the same way; it consists of the establishment

of energy, durable or not. To mold is to modulate in a final way; to modulate is to mold in a continuous and perpetually variable way. ” (Simondon, 2005a, pp. 46-47; 2007b).

By challenging the *hylomorphic* view that reduces technical and artistic creations to the association of passive and abstract *forms* and *materials*, Simondon disputes perspectives that underestimate or ignore the real handicraft and technical processes that are in progress when an artisan works in his workshop. Such perspective ‘corresponds to the knowledge of a man that remains outside the workshop and does not take into account anything except what goes in and what comes out’ (Simondon, 2005a, p. 46). He also rejects the very social and intellectual perspective that segregates technological operations from knowledge and culture and delegates the power to create individuals to an abstract form.

“We could say that, in a civilization that divides men in two groups, those who give orders and those who execute them, the principle of individuation, according to the technological example, is necessarily attributed to either form or matter, but never to both together. ” (Simondon, 2005a, p. 58).

### **Mechanology and the social, ethical and political dimensions of the study of technology**

The critique of the *hylomorphic* perspective is, as can be seen, not simply a matter of *ontogenesis* and *individuation*. It reflects a political, ethical and epistemological framing of reality related to how one understands the relations between humans, nature, machines and culture. Likewise, in the beginning of his thesis on *technical objects*, Simondon underlines the need to recognise these objects as human artefacts in the same manner other objects are recognised, such as books and works of art. From this comes his claim to reintroduce technical things ‘in the culture’, surpassing misoneistic and technophobic approaches to technology.

“The opposition established between the cultural and the technical and between man and machine is wrong and has no foundation. What underlies it is mere ignorance or resentment. It uses a mask of facile humanism to blind us to a reality that is full of human striving and rich in natural forces. This reality is the world of technical objects, the mediators between man and nature. Culture behaves towards the technical object much in the same way as a man caught up in primitive xenophobia behaves towards a stranger. This kind of misoneism directed against machines does not so much represent a hatred of the new as a refusal to come to terms with an unfamiliar reality. Now, however strange this reality may be, it is still human, and a complete culture is one that enables us to discover that this stranger is indeed human. Still, the machine is a stranger to us; it is a stranger in which what is human is locked in, unrecognised, materialised and enslaved, but human nonetheless. The most powerful cause of alienation in the world of today is based on misunderstanding of the machine.” (Simondon, 1989, pp. 9-10; 1980, p. 11).

Thus, the theoretical question that arises relates to acquainting the humanities with the gestures and thoughts set down in the technical objects and their mechanisms. Rather than conceptualising technology in a strictly pragmatic or fatalist way, Simondon refuses both technophobic and positivistic approaches to *technology*, thereby rejecting the broad *alienation* they imply.<sup>4</sup>

However, this *alienation* is not just the political and economic one between men and the means of production identified by Karl Marx (Marx, 1986, p. 60). It is a rather extensive *psychophysical alienation* in the sense that segregation between humans and technical objects implies, first and foremost, an ignorance regarding *machines* and *technical things*, and this separation leads to their reduction to the status of pragmatic means to acquire power. In this technocratic perspective,

“the machine is just a mean; the end is the conquest of nature, the domestication of natural forces by means of an initial servitude: the machine is a slave that serves to make other slaves. (...) But it is hard to free yourself by transferring slavery to other beings, men, animals or machines; to reign over a population of machines is still to reign, and every reign supposes the acceptance of schemes of servitude” (Simondon, 1989, p. 127).

### Regarding *Alienation*

“Man’s alienation in relation to the machine has not only a social and economic sense; it has also a psycho-physiological one; the machine does not extend anymore the body scheme, neither for the workers, nor for those that possess the machines. The bankers whose social role was exalted by the Saint-Simonian mathematicians and Auguste Comte are as alienated in relation to the machines as the members of the new proletariat.” (Simondon, 1989, p. 118).

“But it is true that the economic conditions amplify and establish this alienation: the technical object does not belong to the men that use them in the industrial life. The relation of propriety is, nevertheless, too abstract, and it would not suffice that workers become the owners of machines to reduce abruptly the alienation; to possess a machine is not to know it. (...) We would need to discover a social and economic mode in which, the individual that uses the technical object would not only be the owner of this machine, but also the man that chooses and nurtures it.” (Simondon, 1989, pp. 251-252).

While the first part of *Du Mode d’existence of technical objects* exposes the general Simondonian concepts regarding the specificity of *technical elements* (i.e. infra-individual technical objects), *technical objects* and *technical ensembles*, the second part of this work, which addresses the relationship between technical objects and men, and the courses on *invention* (Simondon, 2005b) and *perception* (Simondon, 2006) expose ideas that are of interest to bring this philosophical framework closer to contemporary sound studies and practices. Simondon develops the theoretical notion of the machine as a dynamic and interactive repository where human thoughts, memories and gestures are translated and registered in the serial memory of gears or other mechanical processes that can be actualised when the technical object is set in motion.

This global perspective leads Simondon to propose *mechanology* as a science that, parallel to the study of single technical elements (i.e. *technology*), would be directed to the study of the *individual technical objects*.

“Infra-individual technical objects can be called technical elements. They differ from true individuals in the sense that they have no associated milieu. They can be integrated into an individual. A hot-cathode tube is more a technical element than a complete technical individual. It can be compared to an organ in a living body. In this sense, it would be possible to define a new science of general



organology. This science would involve the study of technical objects at the level of the element. It would be part of the science of technology, including mechanology, whose subject of study would be complete technical individuals” (Simondon, 1989, pp. 64-65; 1980, p. 56).

### Human-machine coupling

The relationship between humans and machines essentially comprises a *coupling* relation. While this interaction is characterised by the physical and gestural *coupling* that takes place when humans use tools, e.g. shovels and levers, there is also a *cognitive* or *psychological* dimension in this relation, i.e. the *coupling of memories*.

“Machines could not store *shapes*, but only their *codification in series* – such as the gears’ teeth, the bits in a digital computer or, in analogical surfaces, the magnetization variation along an electroacoustic tape or the groove curves of a vinyl disk.” (Velloso, 2013, p. 125).

On the other hand, humans can retain the overall *shape* in memory but are not as capable as machines to store a large amount of data in a given series.

The coupling between these two kinds of memories (and the related physical and gestural operations) thus depends on a sort of common coding. The ‘good’ coupling between these two different *memories* happens

“from the moment in which it is possible to achieve a partial convertibility between them, so that a synergy becomes possible. (...) There is coupling when a single and complete function is fulfilled by the two beings”(Simondon, 1989, p. 124).

According to Simondon, alienation occurs when this function is compromised somehow, i.e. not only when it is interrupted or unachievable given specific or contingent circumstances, but also when it is disturbed: when the technical interaction of human beings does not imply a meaningful translation of the gestures, thoughts and procedures registered and encoded in the machine mechanisms.

If the *coupling* of humans and machines presupposes the *translation* of what is encoded in the mechanisms of technical objects to human memory, the process of human-machine *coupling* depends on the meaningful fulfilment of a ‘single and complete function’ and imposes further challenges to this process. In concrete terms, a long chain of technical mediation between a human being and the technical operation that interposes the translation between these two *memories* is established. Therefore, increasing effort is required to understand the technical elements and mechanisms that take part in the machine’s operation. If it is true that such a task is nearly utopic in the concrete *coupling* between humans and most technical objects of our time, this synergy can be sought in different levels to establish the relationship between humans and machines that Simondon endorses.

It is especially relevant to think about activities, such as those we are accustomed to undertaking in sound practices and studies, that presuppose human-machine interactions in various processes, such as *creation* and *invention*. According to this perspective, to be able to establish a meaningful *coupling* with machines in contexts that imply *creation/invention* is to be able to ‘make your mind operate as a machine would operate’

and, conversely, to understand the machine operations and mechanisms as the mechanical reproduction of human ideas and gestures.

“The machine is a deposited human gesture, fixed, transformed into stereotype and power of resumption. (...) Between the man that invents and the machine that operates there is a relationship of isodynamism, more fundamental than the one that Form psychologists had imagined to explain perception by naming it isomorphism. The relationship of analogy between machine and man is not at the level of the corporal operations; (...) the real analogous relationship is between man’s mental operations and the physical operations of the machine. These two operations [*fonctionnements*] are parallel not in ordinary life, but in invention. To invent is to make your mind operate as a machine would operate, not according to causalities, too fragmentary, nor in accordance to the goal, too unitary, but in accordance to the dynamism of an operation that was lived, captured, because it was produced, witnessed in its genesis. The machine is a functioning being. Its mechanisms concretise a coherent dynamism that once existed in thought. Thought’s dynamism, while the invention occurred, was converted in functioning forms. Conversely, the machine, while it operates, produces or goes through a number of variations around the fundamental rhythms of its operation as they result from its defined forms. It is these variations which are meaningful, and they are meaningful with respect to the archetype of operation that is thought in the process of invention. One has to have invented or reinvented the machine so that the operation variations of the machine become information.” (Simondon, 1989, pp. 138-139).

In an optimal *coupling* between humans and technical objects, the operation one tackles while interacting with a machine involves the ability to recognize, decode and interpret human gestures and thoughts captured and registered in its operating mechanisms at the moment of invention. To invent, on other hand, consists of being able to formulate the isodynamic analogy that enables the inventor to inscribe in gears, programs or any kind of dynamic technical process his thoughts and gestures. Finally, to operate or use a machine is, ideally, to understand how the input gestures that control the mechanism modulate the actions of the human-technical couple and make the whole engine work.

### **Technical methods – instruments/tools (*appareils/ustensile*), machine-tools/machines, and networks**

While the ideas presented in the two books summarised above allow us to glimpse a potential impact of Simondon’s thought in practices and studies, it is worth presenting a further categorisation that Simondon undertook to understand the specific particularities of certain types of technical operations with specific *technical objects*.

In his 1968 lecture *L’Invention et le développement des techniques* (2005b), Simondon establishes five different technical stages to understand *technology* and *technical objects* and their relation to human activities. These stages correspond to: (1) the *technical method*; (2) the *tool* and the *instrument*; (3) the *apparatus* and the *utensil*; (4) the *machine-tool* and the *machine*; (5) and the *network*. While the differentiation between these stages is interesting relative to anthropological theory of technological development, it is mainly relevant because it enables us to think about specific technological operations and objects, as well as the overall characteristics implied when we use certain tools, instruments and other technical objects when dealing with sounds and music.

The first technical stage, i.e. the *technical method*, is characterised by Simondon as the pre-instrumental technique. The *technical method's* main characteristic relies on the massive, synchronic and fractionalised execution of a given task by a group of individuals with essentially no tools, instruments and technical objects. This process occurs in human work (as in the primitive techniques of construction and material transportation) and in animal behaviour (as in the coordination of the individual activities of bees and termites) (Simondon, 2005b, p. 87).

The second technical stage replaces the synchronic, fractionalised and massive unmediated execution of a task by more individualised and mediated work with tools and instruments. At this point, Simondon makes a conceptual distinction between *tools* and *instruments*. While *tools* are prosthetic regarding the *actuation* of the living being in the world, the main function of *instruments* is to mediate our *sense* organs.

Both *tools* and *instruments* have three main functions, i.e. *extension*, *transformation* and *isolation*. Drumsticks, violin bows and guitar plectrums are examples of *tools* that undertake those functions in actuation through musical instruments, which, according to this terminology, we could refer to as *musical tools*. On the other hand, microphones, noise cancelling headphones and earplugs are examples of *instruments* that *extend*, *transform* and *isolate* our auditory senses in specific situations, respectively.

Of course, this categorisation is schematic and does not intend to individualise *functions* or segregate *instruments* and *tools* as necessarily distinct technical objects. A single *tool* or *instrument* typically performs multiple functions by *extending*, *transforming* and *isolating* our interaction with the world. Likewise, *technical objects* usually act as both *instruments* and *tools*. This integration of functions can be illustrated easily by a walking stick that, as a *tool*, extends our hands and arms to 'reach' the floor and support the body and, at the same time, is used to extend, transform and isolate the *sense* of touch, thereby allowing one to *feel* the floor characteristics through the walking stick.

The third technical stage is qualified by the introduction of *apparatus* [*appareils*] and *utensils* [*ustensiles*], which reveal the coupling of *tools* and *instruments* to a mechanic nucleus that modulates the relationship between inputs and outputs.

“The second technical revolution is the detachment of the technical object from the operator's organism: the instrument works as an input to the *apparatus*; the tool works as an output; the *apparatus* is thus the central point, the mediator of this coaptation between an instrument and a tool through a source of energy, that makes the machine. One could say, therefore, that the machine is constituted by the process of individuation in which the center is the *utensil*, plus the *apparatus*, node of the relation, entrance of the auto-correlation and starting point of the independence from the human organism that acts as holder and as a draft, since the instruments and tools that were created for the operator organism can be brought to the machine at the expense of adaptive modifications; in a fractionalised fashion, the organism is thus as a model, as an archetype, to the main sensor and actuator organs of the machine; but it takes a third reality, that of the *utensil* and the *apparatus*, to operate, apart from man, the connection between sensors and actuators..” (Simondon, 2005b, p. 95).

The fourth stage consists of the *machine-tool* and the *machine*. Both the machine and machine-tool are built around a 'central system of correlation that may be a *modulable* source of energy or a device as a gear'. Both have their own energy source to produce work and to correlate sensors and actuators. If *machine-tools* must be operated by humans, they tend to be more and more autonomous regarding human gestures and operation. As *modulators* of human gestures, these objects require a very feeble 'source of input (control) to govern the work transformation (on actuators) from the energy borrowed from an external source (animals, water flow, wind, combustion)' (Simondon, 2005b, p. 97). The *machine* takes this particularity to the extreme, and it is so autonomous relative to human operators that the latter assume the role of observers or sentinels that guard and maintain the machine.

The last stage corresponds to technical networks, in which each machine is an autonomous core that intercommunicates with other machines through receptors and actuators..

"The basic characteristic of the network is the virtual presence of all possibilities of the central organism in every terminal, either in the transmission or in the reception." (Simondon, 2005a, p. 100).

### **Conclusion: towards a solfège of technical objects**

Since Pierre Schaeffer's *sofège* (Schaeffer, 1966) and other subsequent and important theoretical contributions to the field of electroacoustic music, such as David Smalley's *spectromorphology* and *spatiomorphology* (Smalley, 1997; Smalley, 2007) or Leigh Landy's *sound-based music* theorisation (Landy, 2007), a large part of the theoretical enterprises on sound arts and studies have addressed *sound* primarily as a *phenomenon*. With different tools, they address *sounds*' spectral, psychophysiological or qualitative features, describing their different characteristics that can be perceived, analysed or manipulated with the aid of recordings, sonograms and other technological tools. While these theoretical frameworks resulted in invaluable concepts and strategies to produce, categorise, scrutinise and understand *sounds* in different contexts by bringing together a series of interdisciplinary resources from several fields, such as psychoacoustics, phenomenology and structural linguistics, it can be said that the consideration of technical tools and technological mediation processes are primarily contingent on these works.

Even if Simondon does not directly address sound practices and music in his works, his ideas regarding *individuation* and *technology* can lead us to reconsider technology mediation in sound practices and studies. First, while processes such as sound production, transformation and perception are not easily explained in terms of the *hylomorphic* schema of form/matter coupling without losing their dynamic and concrete dimension, they can be fruitfully addressed in terms of *individuation*, *information*, *transduction* and *dephasing*. Sound production and perception are by nature dynamic processes that rely on the propagation of an energy to produce dynamic structures (*information*) that acquire and retain their individuality as long as they preserve a clear boundary (*different phase*) and independency (*phase difference*) in relation to the surrounding sound environment. From a Simondonian perspective, we could think in terms of *individual sounds* (or sounds 'in process of *individuation*') rather than *sonic objects*. Second, the very *technical objects* and *technical chains* that mediate our sound production, perception and manipulation processes acquire, from this perspective, a concrete anthropological relevance and a social, cultural and political dimension. These

tools and their mediation processes determine what we listen to and how we listen, what and how we analyse/theorise, and what and how we create and perform. In the same way that technological acquisition and subsequent refinement of music notation have deeply changed music production, reception and theorisation over the centuries, the technical objects and processes related to sound arts, practices and studies have created specific modes of listening, studying and creating sounds that rely on how we engage these tools and techniques, how we attach our bodies and minds to them while dealing with sounds and even how we invent or reinvent these tools.

This article does not attempt to establish some sort of theoretical programme or present a methodological framework to be applied to the interpretation, invention and reinvention of techniques and technical objects in the immense variety of contemporary sound practices. Nevertheless, the Simondonian theoretical work presents worthwhile ideas and an equally valuable ethical perspective regarding the auditory and creative activities that imply the use of technical means, as well as those that presuppose their invention and adaptation to new enterprises.

If many theories and concepts derived from Schaeffer's connotation of the term *sofège* have enriched how we think about sound and the sound-related creative, analytical and theoretical dimensions, it is possible to postulate a *sofège* that happens *through* technical beings and is also directed at these very technical beings. This does not imply that sound particularities are to be ignored or relegated to a second plane, but rather that we should bear in mind their technological dimension. The *sonic object*, the *spectromorphologically* analysed sound or even the ephemeral live-electronics' 'real-time electronic sounds' produced in interactive contexts are the sounding trails of technological processes, tools, instruments, machines and mediations. These technical resources involve the historical acquisition and accumulation of stereotyped gestures and thoughts and of *modes of listening* and *making sounds*. In Schaefferian terms, we could say that they embody *themes* and *versions*.

Pragmatically speaking, despite any theoretical and philosophical justification, Schaefferian concepts and practices, such as *reduced listening* and *acousmatic music*, are likely to rely more on the ancient *circular* movement of the gramophone, on the corresponding form of the disc recording, which, according to Adorno (1990, p. 59), can be traced back to the automated organs, and on the latent technical possibility to 'freeze' sound in *loops* by manipulating *technical objects*, such as the lathe, turntable and a disc with locked grooves, than on the Husserl concept of *epoché*. This is not to say that these and other concepts (such as those that Schaeffer borrows from linguistics) are not important to his theory and interpretation of sound practices. On the contrary, they proved to be valuable conceptual tools to understand, *a posteriori*, the new sounding phenomena that Schaeffer was only able to listen to, contemplate and manipulate from the moment at which his human senses and organs could be prosthetically extended to enable him to listen to and handle these phenomena as *individual* sounds.

Today, with computational technologies that were practically unthinkable a few decades ago, even when Simondon and Schaeffer wrote about technology a few decades ago, it has become possible to reconsider, once again, the *sofège*, which is an outdated term that, nevertheless, can conceptually gather different practices and activities related to our interactions with sounds and music. For example, we witness the ordinary application of technologies that massively compute and process a large number of sounds to perform the automatic recognition of features through *music information retrieval* and *machine listening* techniques. The retrieved information is analysed using

complex tools, e.g. *machine learning* and *cloud computing strategies*, to accomplish heterogeneous tasks, such as song recommendation systems, recognising and locating screams or gunshots in urban soundscapes and structuring complex surveillance systems that imperceptibly monitor the sounds we produce and listen to.

In this context, the *solfège* of technical objects, i.e. the wide range of processes that encompass understanding and interpreting thoughts and gestures set down in technical objects and their coupling in our sound-related activities, such as listening, performing and creating, may have theoretical and artistic reverberations relative to how we deal with sounds. It could also have political and ethical consequences for practices that refuse, borrowing Simondon's expression, 'any scheme of servitude'.

### Footnotes

1. According to Simondon, the technical object is not merely an instrument or utensil, but the end-product of a technical activity and its evolution (Simondon, 1989, p. 15; Simondon, 2009, p. 19).
2. The creation of a sound loop by making a circular groove in a recording disc (*sillon fermé*) and transforming a bell sound by removing its attack and then repeating loops of this 'cut bell' fragment to create a flute-like sound (*cloche coupée*) are considered the two inaugural experiments of the *musique concrète* (Chion, 1983, p. 18; Schaeffer, 1966, p. 417).
3. The term 'allagmatic' comes from Greek *αλλαγή*, which means 'change' or 'differentiation'.
4. The pragmatic dimension of tools [Zeuge] can be seen when Heidegger stresses the 'wozu' (what-for) and the 'um zu' (for-something) dimensions of instruments (Heidegger, 1967, p. 70). On the other hand, the fatalistic apprehension of modern technology is the guideline of *Die Frage nach der Technik* (Heidegger, 2002).

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