

Progress and Growth. A Comparison between Technical and Biological Evolution

Silvia de Cesare & Vincent Bontems

Résumé

Dans cet article, De Cesare et Bontems comparent les concepts de progrès et de croissance dans l'évolution technique et dans l'évolution biologique, en proposant une analyse critique des analogies entre ces deux domaines. En s'appuyant sur la philosophie de la technique de Gilbert Simondon et sur la théorie évolutionniste contemporaine, en particulier telle qu'elle est développée par Silvia De Cesare, les auteurs distinguent le progrès purement performatif du progrès authentique. Au niveau technique, Simondon définit le progrès comme un processus de concrétisation, par lequel les objets deviennent plus cohérents, autosoutenables et mieux couplés à leur milieu, évitant ainsi les évolutions hypertéliques marquées par une spécialisation excessive. Au niveau biologique, l'article montre qu'il est possible de parler de progrès local comme amélioration fonctionnelle adaptative sans recourir à des valeurs morales, tout en soulignant les limites liées à la fragilité associée à la suradaptation. À des échelles de temps plus longues, l'évolutivité est proposée comme critère d'un progrès organique global, entendu comme la capacité à générer de la diversité face à l'instabilité environnementale. Enfin, le texte dissocie le progrès de la croissance (démographique ou économique), en soutenant que la situation écologique contemporaine exige de repenser le progrès technique indépendamment de l'augmentation quantitative, ouvrant même la voie à l'idée d'un « progrès négatif » orienté vers la soutenabilité, la réduction de la puissance et la préservation de l'évolutivité des systèmes vivants.

Mots-clés : Progrès technique et biologique; Philosophie de la technique; Concrétisation; Évolutivité; Progrès et croissance.

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Abstract

De Cesare and Bontems compare, in the article, the concepts of progress and growth in technical evolution and biological evolution, offering a critical analysis of the analogies between these two domains. Drawing on Gilbert Simondon's philosophy of technology and contemporary evolutionary theory, especially as developed by Silvia De Cesare, the authors distinguish merely performative progress from genuine progress. On the technical level, Simondon defines progress as a process of concretization, through which objects become more coherent, selfsustaining, and better coupled to their milieu, thereby avoiding hypertelic evolutions marked by excessive specialization. On the biological level, the article shows that it is possible to speak of local progress as adaptive functional improvement without appealing to moral values, while emphasizing its limits due to the fragility associated with overadaptation. At longer timescales, evolvability is proposed as a criterion of global organic progress, understood as the capacity to generate diversity in the face of environmental instability. Finally, the text dissociates progress from growth (demographic or economic), arguing that the contemporary ecological situation requires rethinking technical progress independently of quantitative increase, even opening the way for the idea of "negative progress" oriented toward sustainability, the reduction of power, and the preservation of the evolvability of living systems.

Keywords: Technical and biological progress; Philosophy of technology; Concretization; Evolvability; Progress and growth.

Introduction

Technical objects and living beings are connected by a very strong and long-standing analogy, which can already be traced back to Aristotle¹. Today, from an evolutionary perspective that has asserted itself since the publication of *On the Origin of Species* by Charles Darwin², one can easily identify a common point between technical objects and living beings: both have an evolutionary history. Indeed, one can speak of biological evolution just as one can speak of technical evolution. In the biological case, it is possible to identify lineages, that is, organisms that represent the same "branch" of the evolutionary tree. In the technical case, one can analogously refer to technical lineages, a concept developed within the framework of French mechanology by Jacques Lafitte³.

In both domains, the technical and the organic, a central question can be posed

¹ Canguilhem, G., 2008, *Knowledge of Life*, New York, Fordham University Press.

² Darwin, C., 1859, *On the Origin of Species by Means of Natural Selection*, London, John Murray.

³ Lafitte, J., 1932, *Réflexions sur la science des machines*, Paris, Vrin.

in the same terms: does it make sense to say that evolutionary change proceeds “toward the better”? The question amounts to asking whether the concept of progress, including an axiological component and a descriptive component⁴, can legitimately be employed to describe these two types of evolution. The notion of progress as meliorative evolution was introduced by Francis Bacon in the domain of the sciences and the arts⁵. Technical progress proceeds through artifacts that are increasingly efficient according to criteria that remain to be determined. By analogy, in the organic case, the idea of progress designates the fact that the evolution of living beings would imply, in part or in its entirety, a change toward the better⁶.

Alongside the term progress, another term can be used in relation to both domains: that of *growth*. The term growth is used in biology to describe the increases (in size and in number of cells) that occur during the life history of an organism⁷. By extension, it can be used in reference to a population of organisms. Thus, with respect to human beings, the term growth describes the demographic increase of the human population, but also designates, by analogy, economic growth as measured through various indicators. These two types of growth (demographic and economic) are often associated, in one way or another, with technical evolution.

In the case of both living beings and technical objects, it is therefore possible to speak of *progress* and *growth*. However, it is important to avoid presupposing the validity of the analogies suggested by the use of the same vocabulary. In this contribution, our aim is to clarify the way in which these terms can be understood in their respective domains and thus to assess the validity of the analogies. On the biological side, we will refer to evolutionary theory as it originates in the thought of Charles Darwin, by adopting the conceptual framework recently presented in De Cesare⁸. On the technical side, we will rely on the analysis of the mode of existence of technical objects developed by the French philosopher Gilbert Simondon⁹, whose relevance is increasingly recognized in the field of philosophy of technology¹⁰, drawing in particular on the recent synthesis proposed by Bontems¹¹. We will address the following questions:

- a) What does “progress” mean in relation to technical evolution as understood within the perspective of Gilbert Simondon?

⁴ Guffroy, Y., Bontems, V., 2018, “La mécanologie : une lignée technologique francophone ?”, *Artefact*, 8, pp. 255–280.

⁵ Bacon, F., 1605, *The Advancement of Learning*, London, Thomas Huggins.

⁶ Ruse, M., 1996, *Monad to Man. The Concept of Progress in Evolutionary Biology*, Cambridge (MA), Harvard University Press.

⁷ Wilt, F. H., 2025, “Growth”, *Encyclopedia Britannica*, <https://www.britannica.com/science/growth-biology> (last consultation).

⁸ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁹ Simondon, G., 2013, *Du mode d'existence des objets techniques*, Paris, Aubier.

¹⁰ Bontems, V., 2018, “On the Current Uses of Simondon’s Philosophy of Technology”, in *French Philosophy of Technology: Classical Readings and Contemporary Approaches*, Loeve, S., Guchet, X., Bensaude Vincent, B. (eds.), Cham, Springer.

¹¹ Bontems, V., 2023, *Au Nom de l’Innovation. Finalités et modalités de la recherche au XXI^e siècle*, Paris, Les Belles Lettres.

- b) What does “progress” mean in the context of evolutionary theory?
- c) In what way is this organic progress analogous to technical progress *sensu* Simondon?
- d) Given that the Simondonian notion of technical progress is detached from that of growth, what can be said of an analogical notion that would apply to both technology and living beings?

Before addressing these questions, it will be necessary to begin by highlighting the differences and the common points between technical evolution and biological evolution, which will make it possible to keep in mind the respective specificities of these two domains

1. Differences and common points between technical evolution and biological evolution

In her classic study, the philosopher Mary Hesse¹² considers analogy to be a system of relations linking an object or a system of objects (called the source) to another object or system of objects (called the target). Hesse takes from the inductivist epistemology of J. M. Keynes the distinction between the positive and negative contents of analogy. Positive analogy consists in the properties and relations that are common to both objects (or systems), whereas negative analogy consists in the dissimilarities between the two¹³. Beyond an attempt at formalization, her personal contribution was to define the *neutral* content of analogy, namely the set of properties or relations shared by the two systems, but also by many others that do not validate the analogy.

Hesse was the first to point out the difficulties encountered by this framework for analyzing analogies: in order to evaluate the positive, neutral, and negative contents, it is necessary to resort to a weighting of the different properties or relations being compared. However, a distinction must be made between material and formal analogies. Material analogies concern properties or relations that depend on concrete resemblances between objects or systems of objects, whereas formal analogies are established between mathematical formulas that model these properties and relations independently of any material resemblance. Even when it is specified that formal analogies are the ones relevant to science, the oversimplification of the procedure for evaluating analogies has been noted by many epistemologists, among them Leatherdale¹⁴, who emphasizes that formal analogies are established between models of objects rather than the objects themselves. Leatherdale further insists on the fact that an analogy is always established between relations within models. Simondon adopts

¹² Hesse, M., 1963, *Models and Analogies in Science*, London, Sheed and Ward.

¹³ Frigg, R., Hartmann, S., 2024, “Models in Science”, in *The Stanford Encyclopedia of Philosophy*, Zalta, E. N., Nodelman, U. (eds.).

¹⁴ Leatherdale, W. H., 1973, *The Role of Models, Metaphors and Analogies in Science*, New York, Elsevier.

an equivalent definition (“an analogy is a resemblance of relations and not a relation of resemblance”)¹⁵ and distinguishes between structural analogies, which concern properties and spatial relations, and operational analogies, which concern processes and which alone are valid¹⁶. The respective validity of material, formal, structural, and operational analogies as applied to the technical domain has been examined in Bontems¹⁷.

In the case that concerns us, the comparison between technical and organic evolutions also leads to privileging operational analogies and to emphasizing from the outset the importance of the negative content of any possible analogy between biological evolution (as described by Darwinian theory) and technical evolution as analyzed by the “mechanologists.” A first difference is that technical objects, unlike organisms, lack the capacity to reproduce themselves and to generate variability. Seals can produce seal offspring, but forks cannot produce baby forks¹⁸. Genetic drift is a mechanism that can lead to significant consequences in biological evolution, whereas there is no equivalent on the technical side. The industrial “reproduction” of objects is relatively constant and weakly variable. Certainly, technical evolution exhibits many cases in which a fortuitous or deliberate modification improving the performance of an object is carried over into subsequent “generations,” but this means that such a modification has been incorporated through a modification of production processes. Technical evolution therefore does not present operational analogies with the processes of spontaneous mutation, genetic recombination, or reproduction rates.

A second difference is that organic forms are subject to natural selection, which is a mechanical and “blind” process, whereas technical objects can be intentionally selected by human beings. Although some economists¹⁹ draw a parallel between the economic selection of innovations and natural selection, it is necessary to keep in mind the significant differences between the two selection mechanisms. Certainly, biological evolution and technical evolution may display a similar pattern of alternation between phases of diversification and selection, as well as between phases of stability or oriented or divergent evolution according to a succession of “punctuated equilibria.”²⁰ However, the two types of evolution operate on disparate time scales and through radically different mechanisms²¹.

There is then a third operational difference: unlike what occurs in technical evo-

¹⁵ Simondon, G., 2005, *L'Individuation à la lumière des notions de forme et d'information*, Grenoble, Millon.

¹⁶ Simondon, G., 2005, *L'Individuation à la lumière des notions de forme et d'information*, Grenoble, Millon.

¹⁷ Bontems, V., 2017, “Analogies techniques et raisonnements analogiques (une lecture simondonienne)”, in *L'Analyse dans les techniques*, de Beaune, S., HilairePérez, L., Vermeir, K. (eds.), Paris, CNRS Éditions.

¹⁸ Lewens, T., 2024, *Quatre questions à Tim Lewens*, O. Morin.

¹⁹ Zuscovitch, E., 1990, “Progrès technique, évolution économique et sélection naturelle”, *Revue française d'économie*, 5, pp. 105–134.

²⁰ Gould, S. J., Eldredge, N., 1977, “Punctuated equilibria: the tempo and mode of evolution reconsidered”, *Paleobiology*, 3, pp. 115–151.

²¹ Mokyr, J., 1990, *The Lever of Riches: Technological Creativity and Economic Progress*, Oxford, Oxford University Press.

lution, change is irreversible in organic lineages. If an organic form has become entirely extinct (or if another form has succeeded it within a lineage), it cannot naturally reappear²². By contrast, if a technical object is abandoned at a given moment in human history, it may later be rediscovered and reused according to what has been called the “Lazarus effect.”²³ Nothing prevents the reinvention of a vanished object or the reuse of an abandoned process. In other words, the irreversibility of biological evolutions stands in contrast to the omnitemporality of technical possibilities.

When Gilbert Simondon applies to technology concepts drawn from the life sciences (“lineage,” “hypertely,” “milieu”), this in no way implies that he neglects the negative components of the analogy. In a comparison made by Simondon between technical and biological lineages in *On the Mode of Existence of Technical Objects*, the philosopher emphasizes the difference between *the produced* and *the generated*: “Transposed into biological terms, technical evolution would consist in the fact that a species would produce an organ that would be given to an individual, thereby becoming the first term of a specific lineage which would in turn produce a new organ.”²⁴ This possibility, which is specific to technical evolution, stands in contrast to the constraints of biological evolution, in which the transmission of organs between individual lineages does not exist in the natural state.

By contrast, without ignoring the differences, Simondon highlights a common point between technical objects and living beings: both oppose disorder and, ultimately, death. In *Individuation in the Light of the Notions of Form and Information*, Simondon²⁵ advances the hypothesis that “vital individuation would come to be inserted into physical individuation by suspending its course, slowing it down, and rendering it capable of propagation in an inchoate state.”²⁶ He defines the machine as a negentropic organization of matter: “the machine, as a work of organization, is, like life and together with life, that which opposes disorder, the leveling of all things that tends to deprive the universe of powers of change.”²⁷ Thus, vital individuation as well as technical invention are two becomings of physical individuation that *slow down* its dissipative process. The machine, like the living being, resists the dissipation of its potentials and maintains, through its exchanges of matter, energy, and information with its milieu, a metastability. In this respect, the machine and the living being do not share the same status as stable and inert inorganic matter.

This common point represents, in Simondon’s view, the most important positive component of the analogy. In the case of human living beings, technical evolution

²² We will not discuss here human attempts to counter such irreversibility, notably through so-called “deextinction” efforts involving species such as the woolly mammoth (on this topic, see for example Paganeli, B., Galetti, M., 2025, “DeExtinction at a Crossroads: Ecology, Ethics, and the Future of Conservation in the Biotech Age”, *Ecology Letters*, 28(9)).

²³ Eldredge, N., 2011, “Paleontology and Cornets: Thoughts on Material Cultural Evolution”, *Evolution: Education and Outreach*, 4, pp. 364–373.

²⁴ Simondon, G., 2013, *Du mode d’existence des objets techniques*, Paris, Aubier, p. 82

²⁵ Simondon, G., 2005, *L’Individuation à la lumière des notions de forme et d’information*, Grenoble, Millon.

²⁶ Simondon, G., 2005, *L’Individuation à la lumière des notions de forme et d’information*, Grenoble, Millon, p. 152.

²⁷ Simondon, G., 2013, *Du mode d’existence des objets techniques*, Paris, Aubier, p. 18.

constitutes an attempt to obstinately oppose disorder. In both cases, there would therefore be progress when evolution produces individuals that resist entropy more strongly, even though they are produced through very different mechanisms (fabrication and generation). In both cases, while keeping the dissimilarities in mind, it is possible to speak of lineages. The question that now remains to be analyzed is whether (and in what sense) these two types of evolution involve a progress that can be measured by analogous criteria.

2. Technical Progress in Simondon

This brings us to address question (a) mentioned above: what does progress mean in relation to technical evolution as understood within the perspective of Gilbert Simondon? To answer this, we will first discuss technical progress within the lineage and the associated milieu; we will then specify what the criteria of technical performance are and in what sense genuine technical progress is not hypertelic. Finally, we will address the question of progress *beyond* the lineage and the associated milieu.

2.1. “Concretization” and its relativity to “associated milieus”

In Simondon²⁸, technical progress is defined as a process of concretization. A lineage begins with the invention of an “abstract individual.” The object is abstract in the sense that its elements are recruited in order to each fulfill a function contributing to the realization of the technical operation, without the totality of the effects of their interactions being anticipated, in particular certain undesirable effects (heating, friction, etc.). The technical individual then “evolves,” that is, its genesis is modified by agents (the restriction of these agents to human beings being open to discussion: animals or artificial intelligences may also intervene). This evolution takes place through a succession of minor advances (partial modifications) and major advances (global reconfigurations).

Minor advances consist in modifying a subsystem or an interface in order to attenuate the residual incompatibilities between the different elements that make up the technical system, until its organization becomes “saturated,” that is, until no further modification can improve its functioning in one respect without degrading it in another. At the time when Simondon produced this analysis, the Soviet engineer Genrich Altshuller arrived at similar conclusions, but by distinguishing more precisely between three types of “contradictions” encountered in technical evolution: the “physical contradiction,” when achieving an improvement would require a parameter to evolve in two opposite directions; the “technical contradiction,” when the improvement of one parameter leads to the degradation of another; and the “coupling contradiction,” when an improvement entails a degradation of the relation to the

²⁸ Simondon, G., 2013, *Du mode d'existence des objets techniques*, Paris, Aubier.

associated milieu²⁹.

Saturation results from the accumulation of minor advances and requires a major advance in order to be overcome, that is, a reinvention of the global organization of the technical object. This operation consists in redistributing the various functions assigned to the elements, either through a convergence of functions, leading to an increased multifunctionality of the new elements, or through the dissociation of functions previously assigned to a single element. The result is always a more synergistic functioning of the individual, *but also* of the system constituted by this functioning together with its associated milieu. And it is in this respect that the crucial distinction lies between genuine progress, which potentially resolves all three types of contradictions, including the coupling contradiction, and a mere improvement in performance.

It is necessary to emphasize that the technical individual does not find its conditions of existence solely in the internal coherence of its structure with respect to the operation it performs (that is, in becoming progressively less selfdestructive), *but also in the relations that this operation maintains with its milieu*. This milieu is both natural and artificial. The technical individual inserts itself into this milieu and, through its functioning, contributes to bringing it into existence. The process of concretization thus constitutes a progress both toward *autocorrelation* and toward *self-regulation*, which amounts to a tendential naturalization of the artificial individual, becoming increasingly similar to a living individual (which is perfectly “concrete”). In Simondon’s words, “the concrete technical object, that is, the evolved technical object, approaches the mode of existence of natural objects: it tends toward internal coherence, toward the closure of the system of causes and effects that operate circularly within its enclosure; moreover, it incorporates a part of the natural world that intervenes as a condition of functioning and thus becomes part of the system of causes and effects.”³⁰

The progress of technology thus presupposes, in its very definition, an adaptation relative to natural conditions that the object transforms—through its own functioning or through ancillary dispositifs—so that these conditions constitute its associated milieu. Now, this circular causality between the technical individual and its associated milieu is not static, since it consists in the coordination between variations in the regime of functioning of technical objects *and* variations in the associated milieu. Thus, as early as 1958, Simondon arrives at the following precise definition of technical progress: “The necessity of adaptation not to a milieu defined in an exclusive way, but to the function of establishing a relation between two milieus, both of which are themselves evolving, limits adaptation and gives it precision in

²⁹ Altshuller, G., 1999, *The Innovation Algorithm. TRIZ, Systemic Invention and Technical Creativity*, Worcester, Technical Invention Center.

³⁰ Simondon, G., 2013, *Du mode d’existence des objets techniques*, Paris, Aubier, p. 56.

the direction of autonomy and concretization. There lies true technical progress”³¹.

2.2 Two kinds of improvement in technical performance

Let us now try to understand by what criteria one can measure the degree of concretization of the technical individual. Within a technical lineage, the transition between two successive generations of individuals constitutes progress if the coupling of the new individuals with their associated milieu is more *durable*, in the sense that, on the one hand, their functioning is less selfdestructive and, on the other hand, the homeostasis of their associated milieu is maintained. This implies that technical functioning consumes the material and energetic resources of the milieu more sparingly and ingeniously extracts information from it, thereby enabling the regulation of its functioning. One then observes that the progress of concretization coincides with the pursuit of efficiency. Abstract individuals make inefficient use of matter, energy, and information; this is why they are both selfdestructive and destructive. This becomes progressively less the case with increasingly concrete individuals. Concretization is accompanied by *measurable* improvements in performance: the technical individual wears out more slowly, achieves higher efficiency, and integrates information from the milieu more extensively and more effectively.

However, it must be emphasized that Simondon insists on the distinction between evolutions that constitute such progress and other evolutions that are also accompanied by improvements in performance but which he designates as “hypertelies.” This term, borrowed from biological vocabulary, designates the development of a morphological trait that may become counterproductive—for example, the antlers of deer, whose large size provides advantages (notably in competition for sexual reproduction) but can eventually hinder the animal’s movement. Analogously, technical individuals may be adapted to a given milieu and a particular function in such a way as to achieve superior performance, but at the cost of losing their “genericity”³²: they become more vulnerable to variations in the milieu and less effective for other functions.

How can one distinguish between evolutions that are genuinely progressive (processes of concretization) and hypertelic ones? This is not easy to establish on the basis of measuring the performance criteria of the privileged function (*key performance indicators*) within a given milieu. Indeed, in both cases there is an improvement in specific performance. By contrast, one may assume that the difference becomes manifest as soon as one measures the full *set of generic performances of the technical individual*. In his course on “*Invention and the Development of Techniques*,” Simondon³³ develops a rational classification of machines according to their

³¹ Simondon, G., 2013, *Du mode d’existence des objets techniques*, Paris, Aubier, p. 65.

³² Shinn, T., 2008, *Research Technology and Cultural Change: Instrumentation, Genericity, Transversality*, Oxford, Bardwell Press.

³³ Simondon, G., 2005b, *L’Invention dans le développement des techniques*, Paris, Le Seuil.

type of functioning (passive, active, and informational) and their degree—that is, according to the relations between their functioning and the scales within the object and the associated milieu (structure, microstructure, higherlevel scales). Thus, the solidity of a tool’s handle fitting is a “passive performance of the first degree,” the energetic efficiency of an internal combustion engine is an “active performance of the second degree,” and a computer’s capacity to produce meaning is an informational performance of the third degree. This classification constitutes a universal analytical framework for the generic performances of a technical object³⁴. It can be represented in the following table:

Type / Degree	Minor	Intermediate	Superior
Passive	1 Structural qualities <i>E.g.: solidity</i>	2 Material qualities <i>E.g.: resistance</i>	3 Environmental qualities <i>E.g.: stability</i>
Active	4 Qualities of internal Mobility <i>E.g.: mechanical efficiency</i>	5 Qualities of energy conversion <i>E.g.: thermal efficiency</i>	6 Qualities of external mobility <i>E.g.: range and amount of work performed (load/distance)</i>
Informational	7 Qualities of transmission <i>E.g.: speed and fidelity</i>	8 Qualities of amplification <i>E.g.: sensitivity and resolution</i>	9 Qualities of meaning <i>E.g.: processing of complexity through autocorrelation (AI)</i>

The work carried out by Guy³⁵, Guy, Bontems & Minier³⁶, and by Minier & Bontems³⁷ confirms that hypertelic evolutions are characterized by the improvement of a single privileged function, often at the expense of other performances, whereas major advances lead to the improvement of several performances, or even of all of them simultaneously.

Let us take the example of two cases of hypertelic evolution. The customization of the ultrashortpulse laser (LIBS) of the spectroscopy instrument onboard *Curiosity*, a Martian rover, was overadapted to its extraterrestrial environment and, above all, to the conditions of its journey (strong vibrations during launch and landing

³⁴ Bontems, V., 2016, “Sur la classification des objets techniques selon Simondon”, *Artefact*, 3.

³⁵ Guy, T., 2019, “Relecture mécanologique de la lignée des télescopes”, *Artefact*, 10, pp. 99–118.

³⁶ Guy, T., Bontems, V., Minier, V., 2019, “Quel laser pour Mars ? Analyse mécanologique d’une innovation extraterrestre”, in *Gilbert Simondon et l’Invention du futur*, Bontems, V. (ed.), Paris, Les Belles Lettres.

³⁷ Minier, V., Bontems, V., 2016, “Simondon et l’innovation dans les machines spatiales de l’astronomie”, *Nacelles*, 6, online.

on Mars). The main improvement concerned a passive criterion of major degree (stability through the damping of disturbances at higher scales), at the expense of its energy efficiency and the fineness of its operations. Conversely, the laser used to study paintings at the Louvre is extremely delicate but not very robust. Whether in the case of the laser onboard *Curiosity* or in the case of the Louvre laser, both constitute hypertelic innovations.

Unlike hypertelic evolutions, which represent evolutionary dead ends insofar as the object becomes overadapted to a single function in a single environment, major technical advances (or concretizations) are characterized by an increase in all performances and by greater functional diversity. In Maunoury's terms³⁸, the progress of a technical lineage is manifested by a simultaneous improvement of the 'horizon of feasibility' and the 'horizon of creativity.' Thus, the invention of the maser, followed by that of the laser, and finally of LIBS, represent the crossing of thresholds of concretization, with the invention of LIBS making possible both the laser on *Curiosity* and that of the Louvre.

2.3 Technical progress beyond the lineage and the associated milieu

Since the measurement of performance is always relative to the associated environment, and since comparison of the degree of concretization only makes sense within a lineage, it is tempting to conclude that the notion of technical progress has meaning only within a lineage³⁹ and within a specific cultural context of application⁴⁰.

However, Simondon is not satisfied with this restriction: technical progress cannot be reduced to the improvement of a technical scheme; *it also involves the invention of new schemes that replace previous ones*. He thus indicates that the transition from the lineage of electronic tubes to that of semiconductors constitutes a progress in the 'pure operational scheme' of 'asymmetric conductance.'⁴¹ This broadens the assessment of progress to an entire family of lineages stemming from the initial invention: 'one could say that the technical object evolves by generating a family: the original object is the ancestor of this family. One could call such an evolution *a natural technical evolution*.'⁴²

If a technical lineage corresponds to the succession of individuals possessing a technical scheme that carries out the same operation and is subordinated to the same function, the family corresponds to the set of lineages that possess the same 'pure' technical scheme—that is, that carry out operations which are certainly different

³⁸ Maunoury, J.L., 1968, *La Genèse des innovations : la création technique dans l'activité de la firme*, Paris, Presses Universitaires de France.

³⁹ Guchet, X., 2005, *Les Sens de l'évolution technique*, Paris, Léo Scheer.

⁴⁰ Basalla, G., 1988, *The Evolution of Technology*, Cambridge, Cambridge University Press.

⁴¹ Simondon, G., 2013, *Du mode d'existence des objets techniques*, Paris, Aubier, p. 42.

⁴² Simondon, G., 2013, *Du mode d'existence des objets techniques*, Paris, Aubier, p. 43.

but are based on the same physical principle of operation. Following Maunoury⁴³, it should also be specified that this pure scheme must be subordinated to analogous functions; otherwise, the comparison may lose its relevance⁴⁴. It remains to be determined to what extent the previous analyses concerning the measurement of technical progress can be transposed to this broadened framework (beyond the lineage and the associated environment)

Electronic tubes and semiconductors belong to the same technical family because, even though they do not perform the same operations, they use asymmetric conduction to form chains of ‘logic gates.’ When the first transistor was invented, it performed this function less well than highly perfected electronic tubes, yet it already represented a form of progress. To extend the notion of technical progress to a ‘substitution after saturation’⁴⁵ between lineages within the same family, it must be shown that the new technical scheme offers superior *potential* performance according to most criteria. Although the highly concretized object of the first lineage possesses performances superior to those of the abstract object of the new lineage, it also exhibits signs of ‘saturation,’ that is, it can evolve only in a hypertelic manner: any improvement in one type of performance comes at the cost of the degradation of another. Thus, the semiconductor transistor displays a greater potential for evolution than electron tubes, and its lineage did not take long to supplant them⁴⁶. Sometimes, the two lineages can coexist and even be combined within the same technical system. Thus, in the Herschel satellite one finds two different lineages of bolometers: the historical lineage of horn bolometers—robust, perfectly mastered, but saturated—and the innovative lineage of pixel-matrix bolometers⁴⁷.

In the case of comparing lineages that do not belong to the same family—that is, whose principles of operation are radically different but which nonetheless fulfill the same function (such as a computer and a Babbage machine, in which gears play the role of logic gates)—the difficulty is of a different order. Mere comparison of performance can sometimes be misleading, since hypertelic evolutions also increase certain performances. Simondon is cautious about the ‘selfevidence’ of progress in this type of comparison. Common sense readily accepts that the computer represents a form of progress compared to the Babbage machine; but ultimately, one should not be content with observing performance gains alone, and should also consider the relation to the associated milieu: is it more sustainable? In the ‘Interview on Mechanology,’ Simondon even asserts the relative superiority of steam locomotives over electric locomotives under very particular historical circumstances (those of the

⁴³ Maunoury, J.L., 1968, *La Genèse des innovations : la création technique dans l’activité de la firme*, Paris, Presses Universitaires de France.

⁴⁴ See the example of the “wheel” in Simondon, G., 2014, *Sur la Technique*, Paris, Presses Universitaires de France.

⁴⁵ AïtelHadj, S., 2000, *Systèmes technologiques et Innovation*, Paris, L’Harmattan.

⁴⁶ Chevignard, E., 2025, *Du transistor à l’intelligence artificielle*, PhD dissertation, Université ParisSaclay.

⁴⁷ Minier, V., Bontems, V., Minier, V., 2016, “Simondon et l’innovation dans les machines spatiales de l’astronomie”, *Nacelles*, 6.

Liberation), emphasizing their autonomy with respect to the power supply network⁴⁸. This dependence on the associated milieu is not, however, absolute. Simondon could not have accepted the supposition of an absolute incommensurability of contexts⁴⁹.

Simondon could have agreed with Basalla that the wheel constituted a technical family that was little exploited by the Incas because of the specific conditions of their geographical environment (movement across rugged mountainous terrain), biological conditions (the absence of draft animals), and social conditions (the abundance of servile labor), without this implying any technical inferiority of their civilization. However, Simondon emphasizes, in ‘Culture and Technique,’⁵⁰ that machinic industrialization represents a technical progress insofar as it draws its energy from sources other than the bodies of living beings, makes possible the standardization of spare parts—which improves the durability of objects—and tends to free technology from cultural limitations. This does not mean that he defends the myth of progress, deconstructed by Basalla, as a justification for Western imperialism and capitalist exploitation. On the contrary, he denounces the ravages of the overexploitation of natural resources as a ‘rape of Nature.’⁵¹ Moreover, in the 1970s and 1980s, he insists that the growth of industrial activities threatens the homeostasis of the global environment⁵². In Simondon’s definition of technical progress at the level of the individual—as autocorrelation and self-regulation—one already finds a criterion of sustainability in the relationship between the technical system and the associated milieu. This criterion retains its full significance when the horizon of measurement is extended beyond the limits of a single technical lineage or a defined associated milieu. The complexity of translating it into performance metrics, however, becomes extreme because of the diversity of types (passive, active, and informational) and degrees (scale relations with the milieu). Life Cycle Assessment (LCA) procedures give an indication of this complexity.

3. Organic Progress and Evolutionary Theory

Now that the notion of technical progress in Simondon has been clarified, we can move on to questions (b) and (c) mentioned above: what can ‘progress’ mean in the context of evolutionary theory, and in what sense is this organic progress analogous to technical progress *sensu* Simondon? To answer these questions, drawing on the contribution of De Cesare⁵³, we will discuss the issue of organic progress, each time highlighting, by way of contrast, the positive content of the analogies with technical progress as conceived by Simondon. We will begin by examining local organic progress, showing in what sense adaptive change within a lineage can be described

⁴⁸ Simondon, G., 2014, *Sur la Technique*, Paris, Presses Universitaires de France.

⁴⁹ Bontems, V., 2023, *Au Nom de l’Innovation*, Paris, Les Belles Lettres.

⁵⁰ Simondon, G., 2014, *Sur la Technique*, Paris, Presses Universitaires de France.

⁵¹ Simondon, G., 2014, *Sur la Technique*, Paris, Presses Universitaires de France, p. 15.

⁵² on this point, see the contributions in Barthélémy, J.H., Duhem, L. (eds.), 2022, *Écologie et Technologie. Redéfinir le progrès après Simondon*, Paris, Matériologiques.

⁵³ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

as progressive. This will also make it possible, by analogy with Simondon's analysis, to clarify the difference between hypertelic and nonhypertelic adaptations. Finally, we will address the question of the possibility of an organic progress that goes beyond mere improvements in performance.

3.1. Context of the Debate and the Conceptual Framework Proposed by De Cesare (2026)

The idea of organic progress is intricately entangled with the history of biological thought. Ruse⁵⁴ is well known for having shown that in Darwin, as well as in many twentieth-century evolutionary biologists, one can observe the persistence of the idea that evolution entails a change for the better. The American paleontologist Stephen Jay Gould⁵⁵ argued that this idea is not at all implied by the very framework (the '*bare bones*') of evolutionary theory: it persists within biology for extrascientific reasons (such as *Homo sapiens*' desire to conceive of itself as superior to other organisms), rather than for reasons internal to the theory itself.

Recently, the work *Organic Progress and Evolutionary Theory*⁵⁶ has sought to shed light on this issue, which remains a source of controversy to this day. Starting from the observation that a change for the better presupposes an axiological opposition between good and bad, the author examines the meaning of these normative terms and clarifies that, within evolutionary theory, it is possible to assert 'x is good' in the sense that 'x has instrumental value for z.' This analysis, drawing on the work of Rosenberg and McShea⁵⁷, makes it possible to rule out any appeal to value in the sense of final value, in which x would be intrinsically good as an end in itself. This reference to instrumental value allows any notion of good/better in the moral sense to be excluded. De Cesare⁵⁸ thus proposes to speak of organic value, according to which it makes sense to formulate statements such as 'an organ is good for a biological function' or 'a biological function is good for the survival and reproduction of organisms.' Such statements, indeed, make sense in relation to organic performance in a given environment. For example, one can assert that 'a shell is good for the function of defense in gastropods, in such-and-such an environment,' and in turn that 'this function is good with a view to the survival and reproduction of the organism, in such-and-such an environment.' De Cesare⁵⁹ therefore proposes speaking of good/better in this very specific sense, which describes the relationship between organic entities and their environments.

3.2 Local organic progress: the adaptive process within a lineage

⁵⁴ Ruse, M., 1996, *Monad to Man*, Cambridge (MA), Harvard University Press.

⁵⁵ Gould, S. J., 1985, "The paradox of the first Tier", *Paleobiology*, 11(1), pp. 2–12; Gould, S. J., 2002, *The Structure of Evolutionary Theory*, Cambridge (MA), Belknap Press.

⁵⁶ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁵⁷ Rosenberg, A., McShea, D., 2008, *Philosophy of Biology. A Contemporary Introduction*, New York, Routledge.

⁵⁸ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁵⁹ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

On the basis of this notion of organic value, De Cesare⁶⁰ examines the notion of local progress, that is, improvements in performance that concern short and medium scales in evolutionary time. The author follows Dawkins's⁶¹ proposal, according to which the very concept of adaptation already involves a reference to a 'change for the better': namely, the fact that equipment for survival can improve within a lineage in certain evolutionary situations. According to Dawkins, the comparison concerns ancestors and descendants within a lineage⁶². Taking the example of gastropods again, and adopting Dawkins's criterion, it would be possible to argue in favor of an improvement of the shell (from a biomechanical point of view) within the lineage. This kind of empirical work has been carried out, for example, by the paleontologist Geerat Vermeij, who has shown such improvements in marine gastropods through the fossil record⁶³. One may also cite observations of improved performance in experimental evolution studies, such as Richard Lenski's *LongTerm Evolutionary Experiment* (LTEE)⁶⁴.

De Cesare⁶⁵ proposes that when this kind of adaptive process occurs, it is possible to speak (with reference to the notion of organic value) of a functional improvement of organic traits (*Functional Improvement of Organic Traits*). In other words, adaptation can be understood as an improvement in performance, within a lineage, in a local environment. The author also emphasizes, following Lewontin⁶⁶, that this requires considering organic traits 'in isolation,' that is, decomposing organic traits and the environmental problems organisms face. As noted by Lewontin⁶⁷, this requires assuming a *ceteris paribus* clause (all other things being equal) with regard to the other traits. For example, when we say that more recent gastropods exhibit shells that are more resistant to breakage compared to those of past gastropods, we assume a *ceteris paribus* clause with respect to the ways organisms respond to other environmental challenges (resource acquisition, reproduction, etc.).

This analysis presents noteworthy similarities with the technical progress within a lineage as described by Simondon. We have seen that, for the philosopher, the improvement of a technical object presupposes an adaptation to the *associated milieu* (which the object itself helps to create) through selfregulation, that is, also in relation to variations in that milieu. In the organic case, during an adaptive process, there is likewise a relation between two terms: organisms (which can be decomposed into organic traits) and a more or less variable local environment. One would therefore have an analogy of the following kind:

⁶⁰ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁶¹ Dawkins, R., 1997, "Human chauvinism", *Evolution*, 51(3), pp. 1015–1020.

⁶² Dawkins, R., 1997, "Human chauvinism", *Evolution*, 51(3), pp. 1015–1020.

⁶³ Vermeij, G. J., 1987, *Evolution and Escalation: An Ecological History of Life*, Princeton, Princeton University Press.

⁶⁴ See the discussion in De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, section 7.

⁶⁵ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁶⁶ Lewontin, R. C., 1978, "Adaptation", *Scientific American*, 239(3), pp. 212–218.

⁶⁷ Lewontin, R. C., 1978, "Adaptation", *Scientific American*, 239(3), pp. 212–218.

- The technical object (T) is in relation to its associated milieu (more or less variable).
- The organism (O) is in relation to its local environment (more or less variable).

In both cases, there can be improvement over time in the sense that one can observe, within the lineage of T or within the lineage of O, better performances in descendants, in contexts comparable to those of their predecessors. In both cases, it is possible to focus attention on a specific performance criterion. One would therefore have an analogy of the following kind:

- Within the lineage of T, the T‘descendants’ display better performance than the T‘ancestors’ with respect to a given criterion (e.g. parsimonious consumption of resources) in an analogous environmental context.
- Within the lineage of O, the O‘descendants’ display better performance than the O‘ancestors’ with respect to a given criterion (e.g. parsimonious consumption of resources) in an analogous environmental context⁶⁸.

In the same way as in the technical case, it is possible to evaluate an organism with respect to multiple performance criteria. In the case of adaptations, the strategy borrowed from Lewontin⁶⁹ consists in saying that one observes an improvement in performance with respect to a specific criterion, while assuming a *ceteris paribus* clause for the other performances. We have also seen above that, in the technical case, performance improvement can take two forms: hypertelic and nonhypertelic. Is there something similar in the organic case? For a technical object, Simondon argues that it is not viable to have an ‘exaggerated specialization,’ to be adapted ‘to a milieu exclusively.’⁷⁰ For example, Simondon considers that early airplanes, ‘which could land in open countryside, were less functionally overadapted than modern airplanes.’⁷¹

This would thus be a case of hypertelic adaptation. Simondon suggests that, in the organic case, this would correspond to specialized interspecific interactions, ranging from symbiosis to parasitism. One might think of the case of the tambalocoque (*Sid-eroxylon grandiflorum*), a tree endemic to Mauritius and threatened with extinction⁷². The seed of this tree is surrounded by an extremely hard endocarp, which must be broken for the seed to germinate. One hypothesis is that, in the past, the function of

⁶⁸ Here one can point to a negative analogy between the technical and the organic cases (see De Cesare, S., 2019, “Disentangling organic and technological progress...”, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 73).

⁶⁹ Lewontin, R. C., 1978, “Adaptation”, *Scientific American*, 239(3), pp. 212–218.

⁷⁰ Simondon, G., 2013, *Du mode d’existence des objets techniques*, Paris, Aubier, pp. 61 and 65.

⁷¹ Simondon, G., 2013, *Du mode d’existence des objets techniques*, Paris, Aubier, p. 61.

⁷² De Cesare, S., 2022, “L’idée de progrès chez Simondon”, in *Écologie et Technologie*, Barthélémy, J.H., Duhem, L. (eds.), Paris, Matériologiques, pp. 31–48.

enabling germination was ensured by passage through the digestive system of the dodo⁷³. The extinction of the dodo, which occurred at the end of the seventeenth century with the arrival of Europeans, would have put an end to this possibility of germination. If this hypothesis is correct, it would mean that the tambalocoque was overadapted: its exaggerated specialization would have placed it in a position of fragility with respect to changes in environmental conditions.

The existence of hypertelic adaptations nevertheless remains compatible with the criterion of local organic progress proposed by Dawkins⁷⁴ and revisited by De Cesare⁷⁵: it is entirely possible for an improvement in organic performance to occur within a lineage and for this to later result in the extinction of that lineage following a change in the environment (because of overadaptation). The notion of local progress therefore does not allow one to distinguish as clearly as Simondon would wish between adaptation and overadaptation, since progress can be accompanied by a form of ‘organic fragility.’ It may thus appear somewhat disappointing. To determine whether, in the biological case, one might hope to find a more robust notion of progress, it is necessary—just as Simondon also recommends when evaluating technical objects—to focus on the question of organic progress over long time scales, that is, on the question of global progress.

3.3 Long-term organic progress: evolvability

When it comes to global progress, the issue is no longer one of identifying small local improvements relative to a specific environmental context, but rather of identifying something that would be good for organisms ‘in general,’ that is, tendentially in any environmental context. Ideally, one should be able to observe that such a beneficial property shows an increase in its spread across different environments over the course of evolutionary history, and that this increase is caused by the mechanism of natural selection. Several criteria of global progress have been proposed in the literature and have been summarized by Rosslenbroich⁷⁶. A nonexhaustive list includes: complexity (morphological or hierarchical), energy intensiveness, autonomy from the environment, exploitation of environmental heterogeneity, and evolvability⁷⁷.

The strategy adopted by De Cesare⁷⁸ is to first explain why complexity cannot be a good criterion of global progress. The next step is to reflect theoretically by posing the following question: what would be an environmental problem that presents itself to all kinds of organisms, from microorganisms living in hydrothermal vents to elephants? Drawing on an idea from Georges Canguilhem, De Cesare proposes

⁷³ Temple, S., 1977, “Plantanimal mutualism”, *Science*, 197.

⁷⁴ Dawkins, R., 1997, “Human chauvinism”, *Evolution*, 51(3), pp. 1015–1020.

⁷⁵ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁷⁶ Rosslenbroich, B., 2006, “The notion of progress in evolutionary biology”, *Biology and Philosophy*, 21, pp. 41–70.

⁷⁷ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press, pp. 64–66.

⁷⁸ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

that this problem consists in environmental instability itself. In the long term, what is ‘better’ for organisms is to be prepared for the potential ‘infidelity of the milieu.’ This property is discussed in contemporary biological literature under the name of ‘evolvability.’

Evolvability applies to different biological systems and at different scales: microevolution, macroevolution, genomes, and clades⁷⁹. It is a dispositional concept, since it does not refer to characteristics that are currently in place, but rather to a general disposition to evolve. Evolvability is also necessarily linked to the notion of variability, that is, the disposition to vary. Despite the difficulty of empirically testing whether evolvability does indeed increase over the course of evolution, De Cesare⁸⁰ suggests that it can be considered a criterion of global progress, by reference to the conceptual framework proposed by Bourrat, Daeven, and others⁸¹.

Without going into the details of this framework, the important point to retain is that the evolutionary success of an organism (which we may call a Type1 organism) in an environment cannot be reduced to the notion of adaptation to a given local environment (the reference environment). A second characteristic that must be taken into account is the robustness of the adaptation, defined as the probability that the Type1 organism will leave descendants (of the same type) in an environment different from the reference one. But it is also necessary to take evolvability *stricto sensu* into account: the probability that this organism will generate daughter populations of a different type (Type2), whether in the reference environment or in another one. In short, when these two characteristics are taken into account, it would be reductive to evaluate the evolutionary success of an organism solely by looking at its local adaptation to a given environment. On the contrary, it is essential to consider the robustness of this adaptation and the evolvability potential of the organic form in question.

In what sense would this global progress be analogous to technical progress *sensu* Simondon? This is undoubtedly a positive content of the analogy that must be handled with caution. We have seen that, for Simondon, technical progress cannot be reduced to the improvement of a technical scheme; it also involves the invention of new schemes that replace previous ones. Technical progress beyond a single lineage would therefore also consist in the fact that each stage of concretization brings about an increase in genericity, that is, in the diversification of the functions that can be assigned to the lineage. In this sense, Maunoury⁸² defines the ‘flourishing of the technical lineage’: the ‘ancestor’ technical object evolves by engendering a family of lineages stemming from the initial invention, and the progress of each lineage gives rise to increasingly diversified potential uses.

In the biological case, when one is concerned with global progress, attention

⁷⁹ Bourrat, P., Daeven, K., Villegas, C., 2024, “Evolvability”, *Biology & Philosophy*, 39(4), pp. 1–24.

⁸⁰ De Cesare, S., 2026, *Organic Progress and Evolutionary Theory*, Cambridge, Cambridge University Press.

⁸¹ Bourrat, P., Daeven, K., Villegas, C., 2024, “Evolvability”, *Biology & Philosophy*, 39(4), pp. 1–24.

⁸² Maunoury, J.L., 1968, *La Genèse des innovations*, Paris, Presses Universitaires de France.

is also given to what becomes, over the long term, of an organic form, without restricting the search for improvement to within a single lineage. There is probably a positive content to the analogy: evolvability *stricto sensu*⁸³ would indeed translate into diversification, since it would involve the production of daughter populations of a different type from the initial type. By contrast, it is very important to recall the negative analogies highlighted in Section 1. In particular, the notion of variability that characterizes an organic population—central to the notion of evolvability—has little in the way of an equivalent in the technical case⁸⁴.

4. Progress et Croissance

We have now clarified, on the one hand, the notion of technical progress in Simondon, and on the other hand, the notion of organic progress, while highlighting the positive content of the analogies with technical evolution. In light of these elements, let us now try to address the remaining question: what is the status of the notion of growth in relation to that of progress?

As mentioned in the introduction, the term *growth* is used in biology to describe increases (in size and in number of cells) that occur during the life history of an organism⁸⁵, and by extension in reference to a population of organisms. If one sets aside increases in size during development, *growth would thus refer to an increase in numbers*, whether of cells (for example in the process of cell division) or of individuals that make up a population. We have also seen that this application to populations appears when one speaks of growth in reference to the species *Homo sapiens*, since the term can describe the demographic increase of the human population. With reference to human beings, an even more specific use of the term is found in economic growth. This can be defined as the process by which the wealth of a nation increases over time⁸⁶, the most commonly used indicator to measure it being Gross Domestic Product (GDP). It should be noted that there is not necessarily a correlation between demographic growth and economic growth: a rapidly growing human population may constitute either an advantage or a disadvantage for economic growth⁸⁷. The question that concerns us, however, is the following: *what is the relationship between progress and growth?*

Let us first consider the biological case. We have seen that organic progress can

⁸³ As defined by Bourrat, Daeven et al., 2024.

⁸⁴ Among the technical objects catalogued in the history of technology, one finds few examples of random variations that clearly degrade the performance of an object. Nevertheless, the analogy with biological variability was once defended (Kiesler 1939), by considering “consumerist” objects (designed to be sold according to nontechnical criteria) or simulated objects that are not necessarily realized. However, Bontems (2023) observes that the main French theorists of technology (Lafitte, LeroiGourhan, Simondon, Deforge) conceived technical evolution according to a model that does not require random variability analogous to that of neoDarwinian evolutionary theory (Lafitte even proposing an evolution analogous to Lamarckian theory).

⁸⁵ Wilt, F. H., 2025, “Growth”, *Encyclopedia Britannica*.

⁸⁶ Cornwall, J. L., 2026, “Economic growth”, *Encyclopedia Britannica*, <https://www.britannica.com/money/economic-growth>.

⁸⁷ Cornwall, J. L., 2026, “Economic growth”, *Encyclopedia Britannica*.

refer to two things. First, to an improvement in organic performance with respect to a local environment. Second, to the notion of evolvability: the dispositional capacity of an organic form to exhibit robustness in the face of environmental change and a potential ability to generate new organic forms. While the first notion can prove ambivalent, or even counterproductive when environmental conditions change, the second is more robust and concerns longer time scales. What is the relationship between these two notions and that of growth (in terms of the number of individuals in a population)? It certainly seems possible to envisage that an improvement in performance (through adaptation) might confer an advantage on a population over others, giving it the capacity to increase more rapidly in numbers. By contrast, the more robust notion of progress as evolvability does not necessarily go hand in hand with growth, but rather with the production of daughter populations of a different type from the initial one. One might of course think that in a very large population there is more variability, and therefore more potential for evolvability. But one might also envisage a population whose numbers increase very rapidly (at a time t), yet whose longterm evolutionary persistence is threatened by its overadaptation to particular conditions. Conversely, one can imagine an organic form that gives rise to various populations limited in number but that persist over the long term.

Let us now consider the case of the species *Homo sapiens*, whose specificity lies in having extended organic evolution through the evolution of technologies. Here, one must take into account the relations among several terms: the evolvability of *Homo sapiens* as a species, technical progress, and growth (both demographic and economic). It is not easy to identify a strict relationship among these terms, but the current situation strongly suggests that an increase in one of these elements does not necessarily coincide with an increase in another. Certainly, in the past, technical progress coincided with phases of demographic and economic growth, and this occurred without concern for the consequences in terms of the evolvability of *Homo sapiens*. The present situation is different, however, since we have become aware of the finitude of resources, of problems linked to climate disruption, and of the consequences for biodiversity. Demographic and economic growth has clearly been achieved at the expense of the evolvability of many other species, and given the importance of interspecific interactions, one can consider that this degradation potentially threatens the human species itself. As Simondon puts it, the changes brought about in the milieu have exposed *Homo sapiens* to a danger of ‘maladaptation.’⁸⁸ Rather than stubbornly seeking to return to a past situation, it would now be necessary, in order to reverse the trend, to reinvent the notion of progress so that it can accompany the technical system toward degrowth. This seems to be what Simondon suggests when he speaks of ‘regress,’ asserting that ‘the essence of progress can be present within processes

⁸⁸ see De Cesare 2022 on this point

of degradation.’⁸⁹ The idea would be to dissociate technical progress from growth, to lower the threshold of overall power employed, and to proceed with a reduction of human activity.⁹⁰ Such new ecotechnological regulations could make it possible to maintain a viable relationship between *Homo sapiens* and its milieu, thereby preserving the conditions of vital individuation for other species. The assessment of such progress would retain the same orientation—namely, the struggle against entropy and the establishment of a sustainable relationship with a milieu that is now irreversibly affected—but it would no longer rely on local measurements of the performance of organic or technical individuals. To prioritize the evolvability of *Homo sapiens* would require refocusing reflection on the question: with which living beings and technical systems does humanity envision its future?

Bibliography

- Aït-el-Hadj, S. (2000) *Systèmes technologiques et Innovation*, Paris, L’Harmattan.
- Altshuller, G. (1999) *The Innovation Algorithm. TRIZ, Systemic Invention and Technical Creativity*, Worcester, Technical Invention Center.
- Bacon F. (1605) *The Advancement of Learning*, London, Thomas Huggins.
- Barthélémy J-H & Duhem L. (dir) (2022), *Ecologie et Technologie. Redéfinir le progrès après Simondon*, Paris, Matériologiques.
- Basalla, G. (1988) *The Evolution of Technology*, Cambridge, Cambridge University Press.
- Bontems, V. (2016) “Sur la classification des objets techniques selon Simondon”, *Artefact*, 3.
- Bontems, V. (2017) “Analogies techniques et raisonnements analogiques (une lecture simondonienne)”. Chapter in de Beaune, S., Hilaire-Perez, L., Vermeir, K. (editors) *L’Analogie dans les techniques*, Paris, CNRS Editions.
- Bontems, V. (2018) “On the Current Uses of Simondon’s Philosophy of Technology”. Chapter in Loeve, S. Guchet, X., Bensaude Vincent, B. (editors) *French Philosophy of Technology Classical Readings and Contemporary Approaches*, Springer.
- Bontems, V. (2022) « Ecotechnologie : entre exotranscendance et rétroscalabilité » in Jean-Hugues Barthélémy & Ludovic Duhem (dir.), *Ecologie et Technologie. Redéfinir le progrès après Simondon*, Paris, Matériologiques, p. 83-105.
- Bontems, V. (2023) *Au Nom de l’Innovation. Finalités et modalités de la recherche au XXI^e siècle*, Paris, Les Belles Lettres.
- Bourrat, P., K. Deaven and C. Villegas (2024). “Evolvability: Filling the explana-

⁸⁹ Simondon, G., 2015, “Le progrès, rythmes et modalités”, *Critique*, 816; see also Bontems, V., 2022, “Écotechnologie : entre exotranscendance et rétroscalabilité”, in *Écologie et Technologie*, pp. 83–105.

⁹⁰ Bontems, V., 2022, “Écotechnologie : entre exotranscendance et rétroscalabilité”, in *Écologie et Technologie*, Paris, Matériologiques.

- tory gap between adaptedness and the long-term mathematical conception of fitness.” *Biology & Philosophy* 39(4): 1–24.
- Canguilhem, G. (2008). *Knowledge of life*. Fordham University Press.
- Chevignard, E. (2025) *Du transistor à l'intelligence artificielle. Les conditions et les dimensions inventives du design numérique à la lumière de Simondon*, thèse de philosophie des sciences et des techniques soutenues le 16 décembre à l'Université de Paris-Saclay.
- Cornwall, J. L. (2026) “Economic growth.” *Encyclopedia Britannica*, <https://www.britannica.com/money/economic-growth>. Accessed 29 March 2026.
- Darwin, C. (1859). *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life* (1st ed.). John Murray.
- Dawkins, R. (1997). “Human chauvinism.” *Evolution* 51(3): 1015–1020.
- De Cesare, S. (2019). “Disentangling organic and technological progress: An epistemological clarification introducing a key distinction between two levels of axiology.” *Studies in History and Philosophy of Biological and Biomedical Science* 73: 44–53
- De Cesare, S. (2022) « L'idée de progrès chez Simondon : un prisme conceptuel pour envisager les relations entre technologie et écologie » in J-H Barthélémy & L. Duhem (dir.), *Ecologie et Technologie. Redéfinir le progrès après Simondon*, Paris, Matériologiques, pp. 31-48.
- De Cesare, S. (2026) *Organic Progress and Evolutionary Theory*. Cambridge University Press.
- Eldredge, N. (2011). “Paleontology and Cornets: Thoughts on Material Cultural Evolution.” *Evolution: Education and Outreach* 4: pp. 364-373.
- Frigg, R. and S. Hartmann (2024). Models in Science. The Stanford Encyclopedia of Philosophy. E. N. Zalta and U. Nodelman.
- Goudge, T. A. (1961). *The ascent of life. A philosophical study of the theory of evolution*. George Allen & Unwin.
- Gould, S. J. (1985). “The paradox of the 1st Tier – An agenda for paleobiology.” *Paleobiology* 11(1): 2–12.
- Gould, S. J. and N. Eldredge (1977). “Punctuated equilibria: the tempo and mode of evolution reconsidered.” *Paleobiology* 3: pp. 115-151.
- Gould, S. J. (2002). *The structure of evolutionary theory*. Cambridge, MA: Belknap Press of Harvard University Press.
- Guchet, X. (2005) *Les Sens de l'évolution technique*, Paris, Léo Sheer.
- Guffroy, Y. and V. Bontems (2018). “La mécanologie : une lignée technologique francophone ?” *Artefact* 8: pp. 255-280.
- Guy, T. (2019) “Relecture mécanologique de la lignée des télescopes”, *Artefact*, 10: pp. 99-118.
- Guy, T., Bontems, V. (2016) « Simondon et l'innovation dans les machines spatiales de l'astronomie », *Nacelles*, 6, on line. URL : <http://interfas.univ-tlse2.fr/>

nacelles/735

- Hesse, M. (1963). *Models and Analogies in Science*. London, Sheed and Ward.
- Kiesler, J. K. (1939) « Architecture as Biotechnique », *Architectural Record*, New York City, Planners Institute.
- Lafitte, J. (1932) *Réflexions sur la science des machines*, Paris, Vrin, 1972.
- Leatherdale, W. H. (1973). *The Role of Models, Metaphors and Analogies in Science*. New York, Elsevier.
- Lewens, T. (2024). Quatre questions à Tim Lewens. O. Morin.
- Lewontin, R. C. (1978). "Adaptation." *Scientific American* 239(3): 212–218.
- Maunoury, J.-L. (1968) *La Genèse des innovations : la création technique dans l'activité de la firme*, Paris, Presses universitaires de France.
- Minier, V. Bontems, V. and Minier, V. (2019) « Quel laser pour Mars ? Analyse mécanologique d'une innovation extra-terrestre » in Bontems, V. (dir.), *Gilbert Simondon et l'Invention du futur*, Paris, Les Belles Lettres.
- Mokyr, J. (1990) *The Lever of Riches: Technological Creativity and Economic Progress*, Oxford, Oxford University Press.
- Paganeli B. and Galetti M. (2025) "De-Extinction at a Crossroads: Ecology, Ethics, and the Future of Conservation in the Biotech Age". *Ecol Lett.* Sep;28(9):e70217. doi: 10.1111/ele.70217.
- Rosenberg, A. and D. McShea (2008). *Philosophy of biology: A contemporary introduction*. New York: Routledge.
- Rosslenbroich, B. (2006). "The notion of progress in evolutionary biology – The unresolved problem and an empirical suggestion." *Biology and Philosophy* 21: 41–70.
- Ruse, M. (1996). *Monad to Man. The concept of progress in evolutionary biology*. Harvard University Press.
- Shinn, T. (2008) *Research-Technology and Cultural Change Instrumentation, Genericity, Transversality*. Oxford, Badwell Press.
- Simondon, G. (2005) *L'Individuation à la lumière des notions de forme et d'information*, Grenoble, Millon.
- Simondon, G. (2005b) *L'Invention dans le développement des techniques*, Paris, Le Seuil.
- Simondon, G. (2013) *Du mode d'existence des objets techniques*, Paris, Aubier.
- Simondon, G. (2014) *Sur la Technique*, Paris, Presses universitaires de France.
- Simondon, G. (2015) « Le progrès, rythmes et modalités », *Critique*, n°816.
- Temple, S. (1977), « Plant-animal mutualism: co-evolution with dodo leads to near extinction of plant », *Science* n° 197.
- Vermeij, G. J. (1987). *Evolution and escalation: An ecological history of life*. Princeton: Princeton University Press.
- Wilt, F.H. (2025) *Growth*. *Encyclopedia Britannica*. <https://www.britannica.com/science/growth-biology>