

# A New Ground for Analogy: an Epistemo-Ontological Study of Systemic Principles

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ABSTRACT Certain major ontological and epistemological questions facing systems research are interpreted and reconsidered in the light of the Simondonian theory of individuation, which is presented as a framework that can offer them novel solutions.

KEYWORDS Ontogenesis; individuation; analogy; structure; operation; relation; reductionism; unity of knowledge, Simondon

Systems research is predominantly about delineating principles of systems in general, for the purpose of providing a meta-framework that can bring about unification of knowledge at a higher level than those of specialized disciplines. The possibility of formulating systemic principles that can serve this purpose depends on one primary and one secondary condition: Firstly, systems must be of such a nature, or must have such aspects/properties that make them admit of being expressed in formal principles which are *independent* of the nature of systems' *constituents* and secondly, once obtained, *transfer* of such principles from one discipline to another must be possible. These principles have the dual function of *describing* the *organizational structure* and *behavior* of systems as well as explaining their *geneses*; hence systems research, besides its task of analyzing systems, has the objective of accounting for emergent phenomena, self-organization, complexity, thus ultimately of illuminating the transition zones between specialized disciplines.

### 1. Some major questions and problems

In this context, some of the main, still standing questions in front of systems research, and related problems that demand further theorizing can be stated as follows:

(1) On which grounds and by which methodologies can the two tasks of description and explanation be fulfilled? Are they to be treated as two distinct and separate tasks demanding different grounds and methodologies or as parts of a single investigation, or can we altogether do away with the task of explanation by reducing it to the former? Even in the case that we reject a reduction, the predominant approach of investigating the genesis of a system by studying its structure and behavior poses a problem: Assuming that particularly self-organizing systems manifest emergent properties, how can an *analysis* of *already formed* 

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systems reveal the *conditions* of their *geneses*? This problem constantly poses the challenge of accounting for self-organization without resorting to obscure forces which kick start the process of structuration, like inherent tendencies or primary activities for the most part lacking explanatory power.<sup>1</sup>

- (2) What is the relation between system as a conceptual construct and system as an entity or, in another terminology, between formal/abstract and concrete systems? This question is also related to the more specific question of how, to what extent and on which conditions systemic principles can be separated from the inner constitution of the system. The legitimacy of this separation should be grounded theoretically and not only on the basis of pragmatics.
- (3) How do we ground the legitimacy of analogical transfers from one domain to another? The central problem with legitimization of analogical transfer is avoiding false analogies, reductionism or assimilation.

All these problems revolve around how we define "system". The predominant attitude in systems research is to define systems on the basis of their *atoms*,<sup>2</sup> i.e. the relevant constituents, at a predetermined scope and level of abstraction, and the types of interactions among them and with systems' immediate environments.

This attitude is immanent to the quite central methodology of *"analysis* into components-*synthesis* into whole",<sup>3</sup> which is sometimes expressed as the combination of *top-down* and *bottom-up* approaches.

### 2. Identification and examination of the problems

Firstly, starting with the determination of atoms introduces conceptual choices to an undesired degree, thus risk of arbitrariness. The decision regarding the level at which the analysis will stop always involves methodological constraints, necessary limitations forced by the scientific discipline to which the researcher chiefly belongs, and an unavoidable degree of pragmatism. Expressed most superficially, the system does not present itself as partitioned into sub-systems, components and feedback loops: that is achieved by the model. Although it is clear that atoms determined through analysis are the atoms of the abstract, conceptually constructed system and not the constituents of a real system,<sup>4</sup> the risk involved is that the very way in which the atoms are determined might conceal and distort some of the real relations, differentiations or integrations and thus prevent the construction of a model that can function reasonably well in explaining and predicting the behavior of the real system, with acceptable degrees of error.

Secondly, explanation on the basis of identification of *building blocks* and *rules of combination*<sup>5</sup> are paradigmatic of reductionist *mechanicism*; thus systems research, in this way, cannot divorce science from its mechanistic baggage. To examine more thoroughly the limitations and constraints this legacy of mechanistic reductionism, we will look at one of its most common manifestations in the methodology.

It can also be argued that explanations based on the postulation of immanent principles have, to differing degrees, vitalistic assumptions.

<sup>&</sup>lt;sup>2</sup> Although systems differ in their respective degrees of material, energetic, informational and organizational closure, the initial heuristic classification boils down to that, e.g., social systems differ from chemical systems primarily because one is composed of people and the other is of molecules.

<sup>&</sup>lt;sup>3</sup> For an almost sloganic expression of this methodology; see Mario Bunge (2003, 24).

<sup>4</sup> Especially for systems researchers like Bertalanffy, who have a strong neo-Kantian philosophical orientation.

<sup>&</sup>lt;sup>5</sup> Even anti-reductionists like Bertalanffy, who refers to the Aristotelian dictum "the whole is *more* than the sum of its parts" to emphasize that the whole has some reality to it which is not reducible to its parts have interpreted the whole as basically being parts plus relations. See Pouvreau and Drack (2007, 308).

The methodology of *analysis* and *synthesis*, as two approaches whose combination is to yield an adequate account of any system, is based on the fundamental assumption that the rules of synthesis that organize the parts which are arrived at through analysis of an already constituted (given) system would be the very same rules, or *relations*, by which the *original* system is organized in the first place, or can *stand for* them. In other words, the methodological assumption is that how a system emerged in the first place can be accounted for on the basis of the relations that bind together the building blocks, which are products of a previously performed analysis.

Here we have two basic and crucial problems. The first one is that of trying to account for the genesis of a system *retrospectively*, that is, on the basis of properties that belong to the already constituted system. There is no guarantee that examination of the properties of the already constituted system would reveal how it came about in the first place, since the systems that we want to understand the most manifest emergent properties in the strongest sense of the term. Thus what we arrive at through analysis may say nothing about the initial emergence of the system.

The second problem is that the rules of synthesis may not be able to represent, within a reasonable confidence interval, the original relations that bring about systemic organization. Rules of synthesis are abstract, conceptual ties which connect conceptually determined atoms. But what can render them useless in some cases is not just that they are abstract, but the more fundamental fact that the methodology of analysis-synthesis gives them only the function of combining predetermined elements. Conceptualized this way, relations would never be treated on the same level with constituents, but would be seen as secondary; for this reason there is an intractable problem regarding the primacy-conflict between relations and their terms–we are not given a clue about which comes first ontologically and chronologically, and how organized entities first came about.

Moreover, system research widely assumes a *hierarchical stratification* of reality consisting of nested levels of increasingly complex organization, yet it does not adequately explain, without resorting to teleological notions, the means and conditions of this process. Relations, as conceptualized by systems researchers, are established between entities on roughly the same level; thus how are different levels of organization connected to each other? What is the nature of *interlevel* relations?

I will argue that such problems are centered ultimately around the *ontological status of relations*, and thus of organization. Systems research have progressed significantly in the way of overthrowing the *reductionist-mechanicist paradigm* but it has not yet brought about a radical shift in the basic ontological framework itself: It shifted the perspective but not the ontological foundation. Actually these problems are inherited from previous paradigms against which systemic thinking has determined its stance.

The need for a new ontology to meet the demands of the advent of cybernetics and systemic research programs has indeed been addressed, although rarely, throughout the last century.<sup>6</sup> Yet, so far systems research has not been able to establish itself on the basis of its own ontological foundations and scientific paradigm. But there has been a deeply significant and promising, yet largely overlooked attempt at formulating a relational ontology that can assist systems research in its quest for the unification of knowledge by providing a ground for the legitimacy of analogy transfer between domains, and a framework for accounting for the ontogenesis and historicity of systems without begging the question: Simondon,<sup>7</sup> who saluted the advent of cybernetics as the signal of a new scientific paradigm, and formulated his relational ontology just after systemic ideas began to attract attention and controversy, is a figure from whom systems research should definitely benefit.

<sup>&</sup>lt;sup>6</sup> See Gotthard Günter's "Cybernetic Ontology and Transjunctional Operations" (1962, 313-392).

<sup>&</sup>lt;sup>7</sup> As far as I can see, the perspective which comes nearest to that of Simondon in the literature is that of Edgar Morin; although the correspondence remains only at the level of perspective. I was surprised that he never cited or mentioned Simondon despite the fact that his work was available to him much more immediately than the rest of the world, but I found out that I was not alone in my surprise, and this lack of acknowledgement was previously addressed by Etienne Géhin (1974, 134- 139).

### 3. Simondonian Theory of Individuation

In Simondon's relational ontology (2005) relations are not secondary realities that come after their terms, but *primary* realities that co-emerge with them. They have the status of being, thus are not accidental but primarily real. Thus the terms "interaction", "connection", or "tie" do not cover the sense Simondon ascribes to relation. His theory of individuation provides a relational framework which aims at grasping systems through relations that bring about their geneses. Simondon's central notion, "individual", is comparable the most with that of "system", but is more limited in content and extension: every individual is a system but not every system is an individual. Individual, in his terms, is by definition an *open system* which is the site of an ongoing structuration; thus when stable equilibrium and informational closure is reached within a system we can no longer talk about an individual but only of an *individuated being*. Individual, in the strict sense, cannot be separated from (and in physical systems even identical with) the very operation of structuration, hence in the ontogenetic relation which establishes an active exchange between an interiority and an exteriority.

The approach characterizing his philosophy is to understand the individual through its *individuation*, or ontogenesis, rather than an analysis of its organization. Individuation, for him, should not be conceptualized in terms of composition out of pre-existing elements; it must be understood without reference to any concrete or formal individual, because that would beg the question of what an individual is. Rather, individuation must be sought in reference to a *pre-individual* reality.<sup>8</sup> The common denominator of all modes–physical, biological (vital), psychic, collective–of individuation is that a *metastable*, pre-individual domain in suitable energetic, formal and material conditions is triggered by an event of *information*, i.e. reception of a *signal of structuration*. Upon information, a communication medium between two levels of organization is established whereby the previously independent behaviours of the entities at the lower level are unified and, through the whole which they bring about, they are shifted up to a higher level. Individual is this *middle-ground* of communication, the mediator between different levels of organization; thus it is not conceived as a "construction-upon" but as a "communication-between".

### 3.1. Some examples of physical, biological, psychic, social and technological individuation

The Simondonian model of system formation as a process of *information* whereby a metastable domain undergoes structuration upon reception of a signal of structuration can be applied to any domain within which emergence takes place; any domain which is the site of an ongoing development, organization, specialization, adaptation, transformation, or complexity increase. The model accounts for the formation and maintenance of open systems and their sub-systems, which are seats of metastable equilibria; stable equilibrium conditions or closed systems are its limit cases. Thus the examples to which we can apply the model are infinitely many, yet I will give one example of individuation from several major domains of being. Each differs from others regarding its mode of individuation, but a common scheme is operative in all. I will first describe this common scheme, then explicate some of the most basic Simondonian notions and pass to the examples.

The process of individuation, as generally described above, is triggered by *an event of information* by which a signal of structuration is received by a pre-individual domain in metastable equilibrium, and continues through permeation of structuration into the metastable domain, whereby information is prolonged or, in informationally closed systems, merely iterated.

<sup>&</sup>lt;sup>8</sup> The notion of "pre-individual" can be traced back to the perspective of Charles S. Peirce, according to which it is the emergence of regularity, structure, order and uniformity that demands explanation. What precedes regularity and uniformity is conceptualized as a "primeval chaos" ("What Pragmatism is", EP2: 345). Although the general outlook of all theories which do not pre-suppose individuals but rather take an ontogenetic perspective resemble one another, Simondon endorses neither the idealistic assumptions, nor the implicit teleology of Peirce, nor shares his radical reliance on chance and randomness. For a fairly insightful comparison of the two perspectives, see Alberto Toscano (2006).

What Simondon calls "the pre-individual domain" is, superficially, the context, or environment which is not yet the associated environment of a system, but one within which an open system emerges. Within the pre-individual domain, there are no individual elements like particular entities, already established structures, organizations or constituted systems. It should not, however, be thought as a mere aggregate of stuff in a state of highest possible entropy or lowest potential energy, since the individual-the system-is not a composition, ordering or reconfiguration of already existing elements. The pre-individual domain is rich in potentials: it is not at rest, but the seat of conflicting tensions which stem from the incompatibilities of the potential structures, phases and dimensions that can emerge from within it, and the individual is a solution to these incompatibilities by being the medium of communication between previously unconnected dimensions. The pre-individual domain is characterized by metastability. Simondon gives a metaphysical sense to the term metastability, containing but going beyond its literal usage in science, and makes it the characteristic state of any context within which an open system emerges. Metastability, in this extended sense, can be observed in phase-transitions, quantum phenomena, stem cells, brain plasticity, adaptability of a species to a changing environment, psychological resilience or in a tense society ripe for social change.

The generic name Simondon gives to the signal of structuration is "singularity," which can be; a *germ of structure* or a local disturbance in the domain of physical individuation, a signal or message in individuation of technological systems, a particular form, organization or pattern in biological individuation, a novel stimuli, experience, challenge, problem, concept or idea in psychological individuation, and finally a significant event, change in environment, introduction of a new technology or mode of production, a cultural novelty, economic crisis, encounters with different groups and so on in social – or collective – individuation. The singularity, in each domain, initiates a structuration which propagates – each structured part becoming a singularity for its unstructured vicinity – itself in the metastable domain, if the domain is in right energetic – macro – and material – micro – conditions, whereby a communication is established between two previously unconnected orders of magnitude, or levels of organization. Individual, for Simondon, is the very *medium* of this communication; it is the *middle-order* emerging between two orders one of which is bigger and the other smaller than itself in scope.

*Physical individuation* is distinguished from other modes of individuation by three inter-related features: (i) at the end of the process metastable potential is depleted, (ii) only one singularity can be received, thus information occurs once and can only be iterated, (iii) individuation ends with the establishment of a stable equilibrium. The paradigmatic example of physical individuation in Simondon's theory is *crystallization*. The metastable domains of crystallization are typically amorphous solids, or liquids which are super-saturated or super-cooled. The singularity, or germ of structure, is typically a single crystal – a pattern –, or at some cases a local, strong-enough disturbance. Upon the encounter in the metastable domain of the singularity at the right energetic, formal and material conditions – like the temperature, the species of the crystal – structuration starts from a particular location within the metastable domain and propagates itself radially within it. The *individual* in crystallization, and typically in all cases of physical individuation, is the *limit* that puts into communication an order of magnitude smaller than itself – the *micro-level* of atoms – and an order bigger than itself – the *macro-level* of supra-molecular or global properties like electric, mechanical, geometrical or optical properties – by propagating itself as the *medium of communication*.

In the emergence, transformation or maintenance of highly complex systems like organisms or psychic individuals we do not see the iterative propagation of a single pattern or structure, which is peculiar to physical individuation where the potential energy of the system is completely released by the establishment of a stable equilibrium and the resulting structure can only repeat itself. More complex systems are formed basically through the suspension of stabilization and the prolongation of the metastable state.

In biological individuation, in contradistinction to physical individuation,

(i) metastable potential is preserved and is the basis for the plasticity and adaptability of the living system,

- (ii) there is the capacity for continuous information and for reception of different and numerous singularities found both within the environment and within the system, and
- (iii) stabilization is never achieved but continuously suspended through the preservation of the state of metastable equilibrium.

A typical example would be the phenomenon of *cell specialization*. In tissue formation, transformations yielding a specialized cell are carried to the neighbouring cells through the propagation of differentiation, which takes place by way of the establishment of a continuous communication between the *level of individual cells* and *that of major systems* of the organism.

In the domain of *technological* production, the process of *amplification*, which is foundational for most contemporary technological systems, is a paradigmatic example for Simondon. In a simple vacuum tube or transistor, the pattern of a signal of low energy is amplified through the modulation of a current with comparatively very high energy.

In the domain of *psychological* phenomena, *learning* can be given as a typical example within which basically the same operation takes place. Especially in cases where a novel stimulus – whether in the form of sense experience, affection or conception – which requires restructuration and reconfiguration of the established cognitive and affective network is introduced to the psychic system, as opposed to stimuli that can be easily assimilated within the system, the process of individuation as described is operative. Overcoming a traumatizing event, grasping a new idea, adapting to a new conceptual system, learning how to dance or swim, concept formation are all processes within which a domain metastable with respect to a singularity undergoes a structuration. Metastability, in such cases, is produced generally when the already existing structures cannot function efficiently or meet the demands of the environment and thus destabilized with respect to the novel stimulus: the potential for restructuration is created through phases of destabilization.

By the individuation of a culture or society – collective individuation in Simondon's terms – we do not mean a mere coming together of hitherto unconnected atomized individuals through some basic interactions – like it is the case with the Hobbesian "state of nature" – but the emergence of a togetherness between people which is established and maintained through relations by which the lives and fates of the individual members are coupled and each is what he/she is also through the mediation of the whole. Wars of independence or revolutions can be examples of the process of collective individuation. They are always triggered by some significant events and the fulfillment of some conditions, and they can be initiated only if the domain is metastable: if a group of people form a tense togetherness which is rich in potentials, that is, if there are various different tendencies, desires, factors involved and the general anticipation of, and enthusiasm for change.

### 3.2. Transduction

Let us now look at the general features and the methodology of Simondon's theory. Individuation propagates within a physical, biological, mental or social domain or from one domain to another *transductively*, that is, through the conversion of *structures* to *operations* and operations to other structures. An operation is what brings forth, or modifies a structure; structure and operation are the ontological complements of each other. Individuation is an operation, and it conserves and, in phenomena above the physical level, perpetuates pre-individual tensions in the form of structure. Thus structures pertaining to living or psychic systems are not stable ones that result from a depletion of potentials but still metastable to some extent. In opposition to the perspective of Gestaltists who take the "good form" to be "stable" form, Simondon advocates that forms pertaining to complex systems are tense, and thus can yield further individuations: they are forms that can *inform*.

There can be no direct passage from one structure to another, but any restructuring must take place through the mediation of an *operation* (in physical terms the relative stability of a structured state prevents the direct reception of any signal of structuration: first there must be a destabilization and a rise in energy level). A structure by itself cannot be transmitted from one domain to the other. It can only act as a singularity for the operation of structuration within a neighboring domain; thus, in sum, structures cannot connect domains but operations, which are ontologically *relations*, can.

The Simondonian pair of *structure and operation* can help in describing systems better than the pair of *organization and constituents*, which involves basically the traditional *hylemorphic* framework modified historically through the *mechanistic* and *reductionist* thinking – in terms of parts and combinations rules – of modern philosophy. Hylemorphic thinking is still significantly operative in systemic thinking, and shows itself wherever systems are described in terms of a global structure and what underlies it. The chief weakness of hylemorphic thinking is the obscurity of the relation between the form and the matter and its inability to grasp genesis. I have compared *transductive* thinking – in terms of structures and operations – and *hylemorphic* thinking – in terms of constituents and organization – in Table 1.

Structure – Operation	Constituents-Organization
Dynamic	Static
based on explanation of <i>processes of information</i>	based on analysis of <i>individuated</i> systems
describes <i>metastable</i> (flux) <i>equilibria</i> better	describes <i>steady state equilibria</i> better
describes open systems better	describes <i>closed systems</i> better

### Table 1: Comparison of structure-operation and constituents-orgazisation pairs

Besides the differences between the two pairs of notions, transductive view of systems gives a quite different picture of organization compared to the hylemorphic view. The notions like form and matter dictate thinking in terms of hierarchies of nested levels and a stratified reality. Although contemporary perspectives are not openly teleological as those of hylemorphist philosophers, it can be argued that descriptions of levels of organization like ascending steps of higher and higher complexity which culminate ultimately in human consciousness have serious assumptions in assigning different (almost ontological) values to phenomena. I have summarized the differences between transductive and hierarchical views of organization in Table 2.

Transductive Organization	Hierarchical organization
<i>Horizontal</i> propagation of <i>individuation</i> between <i>neighboring</i> domains	Vertical stratification of nested systems
Levels of organization as communicating orders of magnitude	<i>Levels of organization</i> as built on top of one another
Genesis of systems as information	Genesis of systems as <i>composition</i>
No assumption of pre-existing elements but <i>pre-individual</i> domain and <i>information</i> triggered by <i>germ of</i> <i>structure</i> or <i>singularity</i>	Necessary assumption of pre-existing elements as <i>constituents</i> or <i>sub-systems</i>

## Table 2: Comparison of transductive and hierarchical models for the propagation of organization

Moreover, transduction expresses the very nature of the process of individuation as well as the method that needs to be followed to grasp its reality. Parallelly, transductive thought transfers the fundamental operations of each domain to subsequent ones, while modifying them in accordance with the peculiar structures and operations of the subsequent domains. The locomotive of the transductive epistemological process is analogical operations. Analogy, for Simondon, is a real relation between two operations: a relation between relations.

### 3.3. Analogical transfer

Knowledge of structures require knowledge of operations that dynamise them; valid analogies<sup>9</sup> must preserve the *operational scheme* of a system. Defining operations by the structures between which they are exercised would risk being reductionistic, especially if the system under consideration can be defined better by what it *does* more than what it *is*; since ontogeneses of structures would be ignored. *Analytical* study of structural aspects of systems, which characterize specialized disciplines, can be securely undertook if the systems in question are *stable*, established ones which are not subject to ontogenesis.

Analogy is defined by Simondon (2005, p. 563) as *identity of relations*, as opposed to a *relation of identity*. The relation of identity is the ultimate case of structural similarity, whereas analogy is not interested in structure; it is a relation between the holistic operational schematisms, or functionings of two systems. Different phenomena cannot be structurally *identical*, since then they would not be two phenomena but one; however, they can be identical in their operational aspect. There can only be structural *similarity*, which may be a very misleading if utilized heuristically.

Reasoning by resemblance, which concerns itself with structural similarity, yields most of the time to the assimilation of the less known phenomena to a better known one. The major problem with assimilation is its unavoidable reductionism, because the differences between the two phenomena likened to each other are ignored in favour of the commonalities.

### 4. Unity of knowledge through diverse approaches

Physics, chemistry and biology, for Simondon, are *analytical* sciences to the extent that they study the *structural* aspects of phenomena. To the extent that they describe *operational* aspects, the *holistic functioning* of phenomena, they converge with systems research.

Simondon had envisaged the establishment of a *science of operations* based on analogical transfer s – which he referred as "allagmatics" – in the near future when he enthusiastically observed the initial developments in cybernetics. Systems research has progressed significantly to become such a science. Neither the analytical science not the analogical science – the science of operations – can proceed absolutely independently of the other since real (or, roughly, "concrete" systems as opposed to "formal") systems universally have both a structural aspect and a holistic functioning. An absolutely analytical science would depict only a still picture of the world, without any

<sup>&</sup>lt;sup>9</sup> Truth of analogies in a realistic metaphysical sense can also be claimed, and that is what Simondon ventures as a way out of the Kantian blow to metaphysical realism in general. A realism with respect to substances, that is, the claim that mind can have knowledge of substances as they are in themselves, is impossible in the post-Kantian era and rightfully so also for Simondon. But a realism with respect to relations may not be vulnerable to the same attack. The possibility of forming analogies of epistemic value lies in that structures are domain specific but operations are not. One cannot grasp a physical structure in its nature, since that would require a duplication of the physical structure in a psychic – and in terms of the brain, biological – domain and this is an impossibility. The classical correlationalist model of knowledge is bound to fall short of its ultimate project; since the representation – an image or a concept – and what is represented are, in their structural aspect, of different natures. But one does not need to have a crystalline structure in oneself in order to know how crystallization occurs, since crystallization as individuation is an operation, just as thought – when understood independently of its structural aspect – is, and the epistemological task of analogical knowledge is to reach an isomorphism between two operations, and to carry this relation to other cases to illuminate them.

dynamism, and an absolutely analogical science could not situate phenomena in proper domains, classes and categories.

Thus the analytical and the analogical approaches in science should unite their forces: analytical approach in describing the structural aspect of reality where the whole is *equal* to the sum of its parts (Simondon 2005, p565), and analogical approach when the holistic functioning of a given phenomenon is predominant and can be put in relation with another operation (ibid). Adequate knowledge of a real system, in this vein, can be gained only by explicating "*how the functioning, that is to say, the holistic schematism* [of a system]...*and the structure, that is to say, the analytic systematic of the same* [system]: *the chronological schematism and spatial systematic are organized together in being*" (ibid).

Simondon's relational ontology, in this context, can enable systems research to situate itself and the specialized sciences more clearly and elaborately within the whole body of knowledge.

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