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The Non-Systemic Usages of Systems as Reductionism: Quasi-Systems and Quasi-Systemics

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Abstract: Usual reductionism considers systemic, acquired properties as non-systemic, possessed properties. We consider here the non-systemic usages of systems, misunderstood as non-interacting virtual objects or devices, and the misunderstanding between non-complex (first Systemics) and complex systems (second Systemics) as another form of reductionism. This reductionism leads to inappropriate and ineffective approaches, particularly dealing with complex systems such as socioeconomic systems, whose complexity is often misunderstood and neglected. However, this reductionism should be distinguished from mixed usages of systemic approaches suitable to deal with multiple, dynamic, temporary, and partial systemic natures of phenomena related to complex systems. We consider that we should move from the well-defined, often simplistic, world of Systemics to Quasi-Systemics, which is intended as constructionist Systemics, always in progress, non-ideological, multiple, contradiction-tolerant, incomplete, and in its turn emergent. Rather than recommending a pragmatic attitude, we mention two approaches, one methodological approach called Logical Openness and another, the Meta-Structure approach, which is suitable to more formally deal with such multiple aspects and—based on mesoscopic representations—suitable to represent quasiness.

Keywords: complexity; incompleteness; multiple; predominance; quasi; reductionism; usage

1. Introduction

The concept of a system proposed by the General System Theory (GST) [1] was introduced by Ludwig von Bertalanffy (1901–1972). This concept had several disciplinary implementations and fruitful models, and it is also broadly used in metaphorical, extended ways. However, the concept underwent thorough updates, particularly when dealing with problems and phenomena of complexity such as self-organisation, structural dynamics, and emergence [2]. An example of another variation is given by the introduction of the concept of quasi-systems, corresponding to the structural dynamics of complexity [3]. The classical dichotomy of system/non-system is conceptually a useless simplification when dealing with complex dynamics that require multiple approaches. However, behind this there are approaches confusing systems and non-systems; considering systems as local, within non-systemic interaction-less environments, and considering complex systems as non-complex systems. We claim here that this confusion is a kind of reductionism.

This article has two main purposes, both basically methodological. The first one, mainly introduced in Section 1, is to identify reductionist usages of systems as local systems, conceptually compatible with non-systemic environments. In this case systems are intended neither as local sub-entities, nor as sub-systems, nor as members of multiple systems as in processes of emergence. There is a possible confusion of systems due to organisation (first Systemics) and systems due to complexity (second Systemics). The article focuses on the need to distinguish and appropriately deal with this mixed, realistic situation while avoiding reductionist simplification misunderstandings.

The second purpose is mainly introduced in Sections 2 and 3; it considers the multiplicity of approaches according to the DYnamic uSAge of Models (DYSAM), where coexistent but non-confused approaches may have different systemic and non-systemic natures corresponding to the structural dynamics of complexity. In this regard, we distinguish among multi-, inter-, and trans-disciplinary aspects as a methodological framework, avoiding useless and dangerous confusions that may lead to inappropriate approaches. We mention Logical Openness and the Meta-Structural approach, which are suitable to methodologically deal with and model the emerging structural dynamics of complex systems.

This is related to quasi-systems—moving from the well-defined, often simplistic world of Systemics to that of Quasi-Systemics. Quasi-Systemics should be seen as constructionist Systemics: always in progress, non-ideological, multiple, contradiction-tolerant, incomplete, and in its turn emergent.

2. First and Second Systemics

The term 'Systemics' introduced in the literature, such as in References [4,5], refers to a cultural framework based on the ideas of the GST and crossing various disciplines. The GST is based on key concepts such as general interdependence, homeostasis, interaction, openness and closeness, organisation, and resilience. The GST includes a number of approaches based on disciplines such as, for instance, Automata Theory, Catastrophe Theory, Control Theory, Cybernetics, Dynamical Systems Theory, Games Theory, Gestalt, and System Dynamics (SD).

"Systemics and cybernetics can be viewed as a metalanguage of concepts and models for trans-disciplinarian use, still now evolving and far from being stabilized" [4].

Systemics encompasses a corpus of concepts and approaches based on the concept of the system as elaborated upon in almost all disciplinary fields, allowing interdisciplinary approaches between fields such as Biology, Chemistry, Cognitive Science, Computer Technology, Economics, Education, Electronics, Medicine, Physics, and Sociology [5].

More specifically, we distinguish between first and second Systemics, as introduced in the literature ([3], pp. 1–56).

In short, first Systemics is related to non-complexity, while second Systemics deals with complexity. Second Systemics is sometimes referred to in the literature as Post-Bertalanffy Systemics [6].

In one case (first Systemics), interactions occur though fixed possibilities and structures. The system usually acquires the same properties, and the system is intended to work properly. Examples include electronic devices acquiring a property when powered on, i.e., leading to interactions amongst the composing elements, as is employed in self-regulator devices, e.g., heater and air conditioning systems; computers and mobile phones; and control and alarm systems that are activated when exceeding threshold values. In short, it is matter of functioning.

In the second case (second Systemics), interactions occur in non-structured, non-organised ways such as for self-organisation and emergence, as introduced in Section 2.2. This case is matter of multiple, but coherent properties [7]. For this case, examples of acquired systemic properties include behaviours of markets, patterns and behaviours of traffic, flocks, and swarms.

We list in the following terms and concepts used by the two Systemics, allowing an explanatory, clarified comparison and evidence of their non-equivalence.

2.1. *Examples of Words and Concepts of Bertalanffy's Systemics*

Examples of words and concepts used in first Systemics, mainly coinciding with the GST.

- Anticipation;	- Optimisation;
- Automation;	- Organisation;
- Completeness;	- Planning;

-	Computability (Turing's Machines);	-	Precision;
-	Context-independence;	-	Regulation;
-	Controllability;	-	Respect for degrees of freedom;
-	Decidability;	-	Reversibility;
-	Existence of the best solution;	-	Separability;
-	Forecasting;	-	Solvability of problems;
-	Growth;	-	Standardisation;
-	Objectivity, observer independence.	-	Symbolic.

2.2. Examples of Words and Concepts of Post-Bertalanffy Systemics

Problems of second Systemics are, for instance, those of structural dynamics, self-organisation, emergence, and the related acquisition of new properties; in short, the problems of complexity.

We differentiate here between dynamics and structural dynamics. The first case relates to the usual dynamical systems represented by time-dependent variables [8]. The second case, structural dynamics, occurs when structures change such as in phenomena of emergence and collective behaviours where there are sequences of structural, coherent changes ([3], pp. 63–144). In the latter case, structural changes correspond to different rules of interaction, e.g., in flocks based on the consideration of distance, speed, or altitude.

Self-organisation processes are considered as continuous but stable, exemplified by periodic, quasi-periodic [9], or predictable variability in the acquisition of new structures. Sequences of new properties are acquired in a phase transition-like manner, having regularities and repetitiveness.

Examples include the Bènard rolls [10], structures formed in the Belousov-Zhabotinsky [11] reaction, swarms having repetitive behaviour, and dissipative structures such as whirlpools in the absence of any internal or external fluctuations.

Processes are intended as emergent when the sequence of new properties is not regular, not repetitive, but coherent (for instance, having long-range correlations). Examples include the properties of collective behaviours adopted by bacterial colonies, cells, fish school, flocks, herds, industrial districts, markets, mobile phone networks, morphological properties of cities, networks such as the Internet, protein chains and their folding, queues and traffic signals, and swarms. Processes of emergence are observer-dependent [12] as the observer operates in a constructivist [13–15] way deciding the properties to be detected and compared over time. The observer decides scales and variables to be considered, and conceives the experiments and approaches. For a comparison between self-organisation and emergence, see also Reference [16].

We list in the following some examples of properties of complexity which cannot be dealt with by using first Systemics:

-	Coherence as the dynamic establishment and maintenance of a property;	-	Low-energy effects able to break equivalences or symmetries;
-	Constructivism dealing with multiple representations;	-	Multiplicity, including multiple systems established by the same components;
-	Context-dependence, i.e., non-separability from the environment;	-	Networks formed by linked properties;
-	Development versus growth;	-	Non-causality, non-linearity due to networked, systems of events;

- Emergence as the continuous, irregular, and unpredictable but also coherent acquisition of properties (shape and behaviour);	- Non-invasiveness;
	- Non-symbolic computability and representations, as for cellular automata and neural networks;
- Entanglement, non-separability as when expressing the observed in terms of the observer;	- Quasiness as dynamical, structural multiplicity;
- Equivalences as indifferent paths for emergence;	- Role of individuality able to break equivalences;
- Incompleteness as a theoretical impossibility to complete;	- Self-organisation, given by continuous but stable variability in the acquisition of new structures, as for Bènard rolls;
- Induction of properties rather than prescriptions or solutions;	- Structural Dynamics, changes in structure over time;
- Irreversibility as the price of uniqueness;	- Usage of degrees of freedom.

When dealing with complexity, the concepts of first Systemics are not sufficient to maintain a unitary systemic theoretical framework because of the different nature of new properties and problems requiring new theoretical understanding.

3. Non-Systemic Usages of Systems as Reductionism

Reductionism presents itself with various aspects, such as the purpose of explaining properties of the macroscopic with those of the microscopic; to consider the existence of a true (possibly unique) level of description; the completeness of models and descriptions; the existence of objective, context-independent laws; the role of the observer as a generator of relative points of view; reducibility to the optimal scale where everything can be explained; and deductibility from principles. However, it is considered here that reductionism is not always clearly identifiable, but can also be delineated, in our case, in the disciplinary, technical, compositional, generic, and metaphorical use of the concept of systems. In this case the local disciplinary effectiveness of the concept of systems is considered sufficient, not necessarily implying interdisciplinary extensions and coherences.

In this regard, we recall the concepts of multidisciplinary, interdisciplinary, and trans-disciplinary levels, when even simultaneous different gradations between them may occur for different multiple approaches to real cases.

In a nutshell, the multidisciplinary aspect can be understood as when problems are faced side by side with different, disciplinary, specialised, and well-distinguishable approaches that must, however, be coordinated. An example is given by a company that requires engineering, design, accountancy, marketing, and human resources skills, all to be coordinated by the management. Still, everyone does his/her job. It is matter of separated competences and specialisations.

The interdisciplinary aspect can be understood as when problems and solutions in one discipline can be used in another, for example through the different meanings given to the variables of a model. For instance, the well-known Lotka-Volterra model was originally introduced in 1920 by Alfred Lotka as a model for oscillating chemical reactions. Later it was applied by Vito Volterra to predator-prey interactions. Other ulterior applications relate to populations dynamics and economy.

The trans-disciplinary aspect can be understood as the study of systemic properties per se, without reference to specific phenomena. Examples include openness, emergence, coherence, and resilience. The applications of these properties take place in their turn in disciplinary contexts, e.g., resilience in social systems and emergence in biology, with eventual outcomes and other disciplinary applications. A further example is how to keep, induce, or even destroy coherence within a population of interacting agents, e.g., Brownian motion.

In this context local, interacting systemic solutions may transform into new problems (often hastily considered as side effects).

3.1. Systems and Non-Systems

An interesting case considering the problem of using (not confusing) multiple systemic and non-systemic approaches is given by the DYnamic uSAge of Models (DYSAM) when the same problem or phenomenon can be represented in different ways and modelled using different approaches ([3], pp. 201–204; [5], pp. 64–85) that is, in multi- and interdisciplinary ways. This is the situation when the system to be studied is so complex, e.g., constituted by processes of emergence, that it is impossible, in principle, to fully describe it by using either a single model or a fixed sequence of models.

The conceptual background of DYSAM ([5], pp. 64–70) includes the well-known Bayesian method, statistical approaches based on a "continuous exploration" of the events occurring within the environment under study. The method is based on the well-known Bayes' theorem [17,18], named after the reverend Thomas Bayes (1702–1761). The background in physics includes the well-known Uncertainty Principles [19]. One example is given by the approach introduced in 1927 by Werner Heisenberg (1901–1976) [20], in which the measurement of homologous components, such as position and momentum (the product of the mass of an object and its speed), the search for increasing accuracy in knowing the value of one variable correspondingly involves reduction in knowing the value of the other variable. Another example is given by the Complementarity Principle introduced by Neils Bohr (1885–1962) in 1928, in which the corpuscular and wave aspects of a physical phenomenon never occur simultaneously. Moreover, so-called Ensemble Learning using machine learning techniques and algorithms [21] and so-called Evolutionary Game Theory are parts of this background [22–24].

When dealing with complex systems such as collective behaviours, we may simultaneously use models considering, for instance, metrical, topological, and energetic aspects. In the same way, problems may have different non-equivalent aspects to be represented and approached in different ways. For instance, a social problem may simultaneously be political, economic, sociological, and related to defence and security; a business problem may simultaneously be financial, organisational, managerial, and related to marketing, delivery, production, and warehousing processes. Moreover, a problem may have geometric or analytical representations.

DYSAM helps to consider how we may use approaches having different systemic natures, for instance, based on first or second Systemics or having a reductionist, non-systemic nature.

We consider here the issue of the coexistence between classical reductionism and its new form as the non-systemic usage of systems, local non-interacting systems, and—as we may say—systems without Systemics, as for cases summarised in Table 1.

Systemics has a general, global semantic nature and trans-disciplinary, non-prescriptive, perhaps methodological implications, yet it is contextual, conceptually irreducible to the local, partial, and separated. It is Systemics that allows overall coherences and avoids misalignments with the consequent conceptual and phenomenological negative or unwanted effects.

This is a matter of recognising and overcoming possible partial and temporary local effectiveness. It is a matter of different modalities and approaches used simultaneously, such as in DYSAM. It should be discussed how such coexistence cannot suffer from contradiction, in a dialectical way [25], similarly to when we accept the classic and non-classic nature of the matter that is revealed during some phase transitions.

DYSAM introduced the need to use different models of different natures to deal with the impossibility of zipping all the features of complex systems into a single model, while also considering the issue of theoretical incompleteness [26,27].

We consider the case of phenomena with multiple natures such as partial, not long-range, and local systemic natures, as seen in the quasi-systems mentioned below.

The structural dynamics of complexity should be approached not only in pragmatic way that is tolerant of multiple differences, such as with DYSAM, but also by using a more structured methodology and model suitable for the scenario underlined above. In this regard, we mention:

(a) A methodological approach named Logical Openness when a zipped, complete, and explicit model of the system and its interaction with the environment is conceptually not possible ([3], pp. 47–51), [28] because of the theoretical incompleteness [29], varieties of interactions, and structures involved. For clarity, we specify that a model is considered as logical closed when a formal description of the relationships between all state variables is available in the model's equations and a complete and explicit description of system-environment interactions is possible and available. This is not the case, for instance, when dealing with collective behaviours ecosystems and processes of learning;
(b) The more formal Meta-Structure approach, where the meta-structure project considers mesoscopic representations [30,31] and related properties of large varieties of structurally different interactions which are analytically intractable and impossible to represent in explicit ways [32–34];
(c) The concept of quasi-systems mentioned in Section 3. In short, a quasi-system is a system that possesses properties in partial, non-regularly changing ways; having partial or temporal inhomogeneities in its system status; and inhomogeneous possession or emergent acquisition of systemic properties, such as in the case of meta-stability, which is the ability of the system to maintain or switch between states in response to small fluctuations. In short, a system is not always a system and structurally not always the same system. The quasiness of complexity occurs when systemic aspects are predominant only and there is the need to methodologically deal with such aspects.

As mentioned above, we distinguish between non-systemic usages of systems, for instance in non-systemic, non-interacting environments or neglecting their natures of sub-systems or part of coherent multiple systems in the process of emergence, and simultaneous usages of systems and non-systems, as in DYSAM. In the first case it is a matter of misunderstanding the natures of systems, while in the second case it is a matter of multiple usages. As considered by quasi-systems, the coherence of multiple systems in processes of emergence may not be absolute. However, quasi-systems tolerate dynamical changes of states within sequences of supposed multiple systems, when there is temporary, partial, local loss of coherence, and the status of the system is then recovered by processes of resilience and compensation, the interchangeability of entities playing the same roles at different times, the equivalences among roles, and balancing. This is the case when, for instance, long-range correlation is not always 100% valid, ergodicity is partial, and so on. Depending on the nature of the phenomena, this tolerance has a threshold of admissibility, beyond which there are increasing non-restorable desegregations.

The aim here is to consider explicit and implicit aspects of coexistence, transformation, and use side by side with combinations of reductionism as local, disciplinary usages of systems, and non-complex and complex system representations. The interest is to at least recognise this situation.

This coexistence should certainly not only be recognised with the aim of developing processes considered to overcome reductionism, but with the aim of reformulating of problems, allowing new approaches and theorisations.

Is this a bionomic situation destined to be maintained, without having to necessarily or ideologically resolve the situation in the final adoption of Systemics?

It recalls the combination of constructivism and objectivism, of which gradualness is often used, rather than definitive overshoots. Pragmatically speaking, from time to time some objectivism is necessary to simplify, fix the ideas, and establish a starting point, while constructivism helps researchers to avoid getting wrapped up in the same simplified, initial approaches.

3.2. Cases and Examples

We will now consider cases as examples.

First of all, we need to distinguish between the properties possessed, acquired as consequences, and systemic properties continuously acquired.

Examples of properties possessed include age, spatial position, and weight.

Examples of properties acquired as consequences include properties of food after cooking, properties of buildings after renovations, new colours obtained from mixing primary colours, e.g., red-green-blue, and properties of objects after their forging such as knife sharpening, welding, and casting. In the latter cases we speak of results.

In the case of systemic properties, as introduced in the literature [1], they occur due to the interaction (one's behaviour depends on another's behaviour) among components. There are two main kinds of systemic properties (related to the first or second Systemics, see Section 1) continuously acquired through the interaction among components.

Examples of non-systemic usages of systems include non-comprehensive health policies, not considering, for example, side effects, unrelated to other aspects such as waste treatment, pollution, and natural-artificial food quality; or the systemic properties of cars without considering the emergence of traffic and urbanistic plans. Furthermore, in network representations [35–37] the nodes may be systems of different natures and even non-systems, such as detectors, corporate departments, stores, and financial positions.

In Table 1 we list three main different cases of reductionist usages of systems, where mixed and graduated cases are possible when occurring as a methodology and not as confusions and misunderstandings.

As an example of reductionist, simplified usage of concepts of pre-complexity Systemics for phenomena with complex natures, we mention how the problems of the current post-industrial society are complex in nature and require appropriate approaches. Often these issues are still addressed with pre-complexity approaches [38].

Table 1. Three main cases of systemic reductionism.

Case 1.	Confuses systemic, acquired properties for possessed or consequential properties. This may also occur when there is a mixed usage of the two kinds of properties.
Case 2.	Confuses second Systemics properties for first Systemics properties. The opposite case does not arise because the former can be seen as particular cases of the latter. This may also occur when there is a mixed usage of the two kinds of properties.
Case 3.	Uses systemic properties as local, not in a systemic framework. In this case systems are intended as special virtual devices, with no conceptual implications on other problems and phenomena. There is an assumption of no contradiction between systems and their non-systemic usages.

4. Quasi-Systems and Quasi-Systemics

The concept of a quasi-system was introduced in Reference ([3], pp. 155–158), defined as system possessing structural dynamics and dynamical structural aspects of instability due to, for instance, the local or temporal inhomogeneity of its system status and inhomogeneous possession or emergent acquisition of systemic properties. In short, a quasi-system is not always a system and not always the same system. For instance, a corporation does not act always as a system (only during the working hours) and processes of adaptation structurally change the corporation. Living systems change during their metabolism. Living systems structurally change during specific phases such as dealing with aging, polipathologies, and when reproducing.

This concept was introduced to make Systemics more adherent to reality. We may say that we moved from the well-defined, simplistic world of Systemics to Quasi-Systemics. Quasi-Systemics is intended to be a constructivist [39,40] version of Systemics; always in progress, non-ideological, multiple, contradiction-tolerant, incomplete, and in its turn emergent.

Coherence is not formal, but rather carried out while in progress, partial, and through continuous compensations and balancing.

Does Quasi-Systemics become an art revealing its deep constructivist nature? Surely it reveals not only its non-linear nature, but also its intrinsic non-translatability in procedures and formal representations only. Surely Quasi-Systemics cannot be dealt with using Turing machine-like procedures. We cannot avoid the oracle, entity capable of solving problems which do not have to be computable. The oracle is not assumed to be a Turing machine, but simply a black box able to produce a solution for any instance of a computational problem [41].

5. Conclusions

In this article we presented some comments about the possible reductionist usages of systems when confusing systems of first and second Systemics and making non-systemic usages of systems, reduced to non-interacting virtual objects or devices. While mixed usages of systemic and non-systemic approaches are possible to deal with the structural multiplicities of phenomena such as Quasi-Systemics, usages as listed in Table 1 are ineffective since they tend to confuse and misunderstand the natures of problems. In this latter case there is methodological inappropriateness. Metaphorically speaking, methodological inappropriateness represents a way of dealing with subsystems in a suitable systemic way, but it ignores the systemic nature of the global system. This methodological inappropriateness is very serious, for instance, when dealing with social systems. It occurs when the methodology is unsuitable to deal with global, long-range emergent multiple systems and their quasi versions.

In this regard, an example is given by inappropriate understandings of the concept of crisis, leading to unsuitable approaches. Phenomena intended as crises may have non-systemic or systemic natures.

Examples include cases when on-going processes manifest the occurrence of events such as anomalies, discontinuities, degenerations, instabilities, and malfunctions. The original process is intended to deviate from the usual, regular paths, and the sequence of deviations is understood as the process of crisis. The implicit strategy is to repair and restore the proper functioning.

Examples of first Systemics crises relate to systems losing their properties such as becoming imprecise and incomplete; non-optimisable; non-organisable; non-plannable; not well identifiable, separable from their context; uncontrollable; unpredictable; and non-standardised. The implicit strategy is to correct, regulate, and restore the properties of the system.

Examples of second Systemics crises relate to systems becoming complete; predictable, regulatory; reversible; converting non-equivalence into equivalence; losing coherence; losing the emergence of properties, e.g., they come in limited selection; and reducing options.

Suitable interventions have complex natures, such as acting on the energy available; changing the dominance relationship between processes; inserting antagonistic interventions; and introducing suitable perturbations. An example of inappropriateness is given when assuming the suitability of linearity of interventions (more is always better) replaces non-linearity.

In social systems, another kind of crisis occurs when processes lose meaning, by asking for new approaches that move away from replicating the same things even if in optimised ways. The strategy, for instance, to improve, increase quantities, optimise, and reduce prices, loses interest.

Theoretically, this refers to the double-loop versus the single loop of second-order cybernetics. When in a single loop, the system is expected to be controlled by regulating the input as a function of the output. In a double loop, the system is expected to redesign the rules, not just apply them [42].

It is matter of structural changes, mutations, often supported and induced by new ideas, approaches, and technological innovations. Social examples include changes in consuming, dressing, food, holidaying, language, life, study, and working styles.

Another example of loss of meaning is given by the large mainframes in Information Technology, for which the prospective to become larger and larger was impracticable. Similarly, for dinosaurs the prospective of becoming bigger and bigger was unsuitable.

It is possible to draw a parallel with science: when the strategy of insisting on thermodynamics reached its peak, the research then moved on to electromagnetism, then subsequently to optics, and then to quantum physics.

At this point it is easy to realise how misunderstanding first Systemics, non-systems, second Systemics, and use systems in non-systemic ways leads to ineffective, reductionist, and dangerous effects. This is equivalent to using the knowledge of the industrial society to manage the post-industrial society [43,44]. Rather than misunderstanding, it is possible to use the existing knowledge in the conceptual framework of the DYSAM and Logical Openness.

Furthermore, we considered the concept of Quasi-Systemics as a constructionist version of Systemics; always in progress, non-ideological, multiple, contradiction-tolerant, incomplete, and in its turn emergent. The focus here is not on distinguishing correct and non-correct usages of systemic concepts, but rather on possible inappropriateness and on constructivist, in progress, mixed, and even contradictory-tolerant usages. This relates to the equivalences, interchangeability of roles, and principles of uncertainty and indifference in quasi coherences. Examples of possible approaches include DYSAM, Logical Openness, and the usage of meta-structures and mesoscopic properties suitable to represent structural dynamics.

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