SYSTEMS SCIENCE AND CYBERNETICS: THE LONG ROAD TO WORLD SOCIOSYSTEMICITY

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Summary

This introductory article is implicitly divided into two parts. The first tries to integrate the main aspects of the topic that occur within the particular theme "Systems science and cybernetics" (SS&C), together with the definition and differential characteristics of social systems as a paradigm of maximum complexity, and a summarized description of the contributions of this theme. The second implicit part, in line with the underlying philosophy of the UNESCO–EOLSS project, will apply some of the systemic-cybernetic principles to the world inasmuch as it is an interrelated entity of people.

Therefore, after a brief description of the concept of system, a list of essential features of the systemic approach, an account of some typologies of systems, and the universal scope of systems and its historic development, this article enunciates some of the perspectives and problems facing SS&C today, along with the major tendencies that can be discerned in the direction that present studies in these disciplines seem to be taking. Renewed epistemological attention to the observer-subject, the growing importance of information systems, developments in artificial intelligence, the impressive role played by the Internet as a worldwide information system, the preponderance of the systemic approach in modern theories of management, the appearance of critical system theories that attempt to counterbalance certain hard methodologies considered to be overly conservative, the appearance of new schools of thought addressing systemic ethics that confront what is actually done with what ought to be done, or the tendency to integrate theoretical and methodological approaches as thoroughly as possible, are some of the trends that seem to be attracting most attention in the profession. This first part ends with a brief description of the forty-six contributions of the theme grouped under the four subheadings: "Systems theories," "Systems approaches," "Cybernetics," and "Computational intelligence."

Perhaps, the major and more generalized concern underlying most of these contributions, is the state of the "world system" regarded as a set of axiological and human disequilibria of unbearable dimensions. It is precisely in connection with this concern, and from the dual perspective of *systems sciences* and UNESCO–EOLSS, that this article will also build upon the following syllogism: first, it is a proven fact that the world as a whole is unfair and poorly organized for most of the Earth's population; second, one of the most likely causes is that world society does not work as a genuinely integrated and unitary social system; and third, there would be, consequently, some reason to believe that the development of systems sciences may to a certain extent contribute to improving the situation. Hence, the focus of the second part of this article is on how to apply some systemic-cybernetic principles to the world situation. If the world could be viewed as a global system, an attempt could be made to evaluate both the positive and negative results achieved. Great progress in certain fields and parts of the world would then be regarded as opposed to very low levels of achievement and unsustainable differences elsewhere. But the key underlying cause of both tendencies is one and the same: the world social organization. A description of the existing model of the typical nation-state as an integrated participatory socio-political system is, therefore, taken to demonstrate that this universal model upholding the three principles of unity, democracy and responsibility is not applied to the world as a whole. The paper concludes suggesting a number of possible—but certainly not easily implemented—strategies drawn from systems science.

1. Introduction

The idea associated with the word “system” has become extraordinarily universal, used profusely *urbi et orbi* both in the sense attributed to it by systems science, and the more lax and less precise meaning it is given in common usage. In the latter case, system is generally used to express one of two concepts: either a set of interacting material or symbolic elements, or the repetition of facts or phenomena that recur “systematically.” The scientific concept of system, however, even in the most general sense, is defined by rather precise features, namely: first, it is a whole whose breakdown into separate parts would alter its significance; second, the role of the separate parts cannot be understood outside the context of the role of the whole in which they are inserted; third, the total is not equal to the sum of the parts: rather, the existence of the set infers that there is something “additional,” be it positive or negative, which generally renders the mere sum inaccurate; and fourth, the alteration of any given part has a variable effect on the other (mechanical, biological, social, etc.) parts of the system.

From a formal perspective the most general concept of system (S) can be defined, according to Mario Bunge, as follows:

$$S = \langle R(a,b,.....n) \rangle \qquad (1)$$

Where R is the set of complex relations that affects elements a, b,….n.

But out of this formal scientific use, the concept of “system” is really used ubiquitously, and although strange as it may seem, the epistemological operations requisite to the scientific concept are used quite rigorously, albeit unconsciously more often than not. Thus, for instance, anyone, when writing a letter, knows perfectly well that a given word should not be repeated more often than is phonetically acceptable, or that the sentences in the letter are interdependent to the point that words or phrases initially thought to be appropriate in one paragraph often have to be changed because the same words or phrases need to be used in another part of the letter. Everyone knows for a fact, or intuitively, then, that the letter constitutes in itself a *whole* with a meaning of its own and that such meaning governs each and every one of its parts in what is a genuine dictatorship of globality. This article, for example, is a system, and in the same way so is a book and its writing, a building and its construction, a model and its design, a company and its governance, a trip and its planning, or a painting and its creation. Everything depends on the ultimate globality, the purpose pursued. Viewed from this perspective there is barely an activity where the scientific concept of system cannot be applied, although most people, especially those who do not like the word “system” because of the connotations that associate it with notions such as mechanicism, determinism, lack of freedom, manipulation, and so on, are unaware of its inevitable and rigorous application. They, like Monsieur Jourdan, “*font de la prose sans le savoir.*”

Cybernetics, on the other hand, is the science that controls the efficiency of systems. Given that the ultimate aim of any cybernetic system is to improve the relationship between outputs and inputs, the most notable deviations produced are precisely what justify adequate cybernetic control of systems. According to van Gigch, the cybernetic treatment of a system is known to call for:

- setting the aim to be reached in terms of the potential determined by the environment and other conditioning factors
- envisaging when a possible deviation exceeds admissible limits
- instituting some kind of automatic response to minimize deviations.

A thermostat has a single purpose: to maintain a constant room temperature. But since in other systems there are multiple aims to be addressed, overall, the indicators of a given profile must be subjected to cybernetic control, as well as weighted and hierarchically classified in order to prioritize cybernetic action (control). Negative deviations are particularly detrimental to a system's viability. The success of a cybernetic control arrangement depends on:

- the number of indicators in the profile
- their classification in terms of their relative weight and importance
- the instrumentation prepared in advance (i.e. anticipatory cybernetics)
- the estimated cost of such anticipatory action.

Any kind of control is costly, which leads to the need to design automatic surveillance systems to correct the following: first, large deviations; second, randomly recurrent deviations occurring over various periods; and third, deviations that are most explanatory in relation to the overall efficiency of the system. All of this renders cybernetic control enormously complex, which explains its scarce application in societies, afflicted by far too many negative sub-products (social inequality, crime, accidents, unemployment, conflicts, etc.) due to the absence, on the one hand, of anticipatory cybernetics, and on the other, to the inability of classic retroactive cybernetics (larger police forces, more jails, hospitals, more unemployment subsidies, etc.) to correct deviations or their tendency. Instead, on occasion, they even tend to aggravate them.

2. The Essential Features of the Systemic Method

A rigorous application of the systemic method should in principle adopt three main epistemological totalities:

- The ontological totality (the object to be studied should be taken as a whole, together with its more significant environments).
- The theoretical totality (all significant theories able in principle to deal with the object should be considered).
- The technological totality (all kinds of research techniques, qualitative and quantitative, soft and hard, should be taken into account).

After the adoption of these three principles, some rules, like those suggested by Espejo in 1994, could complement the systemic approach to the object:

- understand how the parts relate to each other and constitute larger wholes

- understand interactive processes constituting wholes at multiple levels
- understand how the system works
- understand the likely effects in the whole of local behaviors and vice versa
- understand language and emotions
- ground purpose through shared distinctions and transform these distinctions into interactive patterns enhancing people's actions, making their action more effective.

The concrete systemic methodology to be used in the field of complex organizations have recently been specified by Mwaluko and Ryan in the following way:

- It must enable organizations to deal with organic complexity of management problems. This can be achieved through the promotion of interaction between relevant stakeholders in tackling such problems. Dealing with organic complexity can also be achieved through the identification of any misperceptions of feedback that may occur as a consequence of the implementation of decisions aimed at tackling management problems.
- A systemic method must also help organizations address the cultural complexity inherent in management problems. This can be achieved through the promotion of participation of all relevant stakeholders in the creation of a shared understanding regarding the nature of the problem. The method must also assist stakeholders in exploring different views, interests, and values regarding the problem and its underlying solution.
- A systemic method must also assist organization in dealing with power complexity inherent in management problems. This can be achieved by freeing all stakeholders from forces than can prevent them from dealing effectively with the organic and cultural complexity of problems (see "Critical systems approach," EOLSS on-line, 2002).

3. Types of Systems

There are of course a huge variety of systems. Since the typology elaborated by Boulding in 1956, several classifications and taxonomies of systems have been proposed. It may be useful, for the reader's sake, to describe the comprehensive comparison Martinelli published in the journal *Systems Research and Behavioral Science* (2000), based on different criteria and authors. Thus, following Martinelli's presentation, systems can be classified according to their complexity, for instance, into Boulding's nine categories:

1. Static.
2. Simple dynamic.
3. Homeostat.
4. Cells, flames.
5. Plants.
6. Animals.
7. Humans.
8. Social organizations.
9. Transcendental.

Also based on the complexity of systems, the well-known classification of J. Miller analyzes eight categories:

1. Cells.
2. Organs.
3. Organisms (human, animals, or plants).
4. Groups.
5. Organizations.
6. Communities.
7. Societies.
8. Supranational systems.

Klir and Vallach propose three categories with regard to how systems and their environments interact:

1. Closed systems.
2. Relatively closed systems.
3. Open systems.

Regarding the ability of systems to cope with environmental changes, Sutherland takes into account the following four categories:

1. Autarchic or primitive (they work only with an invariant set of internal and external stimuli).
2. Symbiotic, or bureaucratic and centralized (they are mechanistic; respond even to critical routine demands and are unable to deal with unforeseen milieu changes.
3. Dominant, which are competitive and decentralized (they combine mechanisticity and versality, and react quickly to foreseeable milieu changes, although risking improper strategic choices).
4. Heuristic or emergent (they are creative, structurally and functionally "plastic," and react quickly and often successfully to unforeseeable milieu changes).

Walliser looking at the problems posed by systems and their response to the milieu, classifies systems into four categories:

1. Automatic and sequential, where the ruling program is fixed and modulated by the inputs (for instance, clocks, transfer machines, or programmed elevators).
2. Controlled and regulated, where the ruling program is with fixed parameters or modulated by the outputs (for instance, Watt's regulator or cellular mechanisms).
3. Adaptive and self-optimizing, with variable parameters modulated by the results (e.g. rockets governing or automation and animal behavior).
4. Self-learning and self-organizing, which change with experience (e.g. perceptrons or chess programs).

From the point of view of decision levels, Mesarovic groups the systems into the following four types:

1. Strategic (survival, interaction with the milieu).
2. Tactical (self-organizing decisions).
3. Operational (detailing tactical decisions).
4 Production (the flow of operational decisions).

Taking into account the levels of self-government, Lesourne emphasizes five types:

1. Externally governed (most machines; Taylor's production).
2. With embedded goals and control (target guides rocket).
3. Self-learning (through rational trial and error).
4. Self-governing (through definition of own goals and self-learning).
5. With multiple deciders (with different immediate goals but rather communal mediate goals).

Jantsch, looking at the levels of self-organizing behavior, presents the following classification:

- Rigidly controlled (Tylor' production; bureaucracies).
- Deterministic (vertically organized; production lines).
- Purposive (industrial; functional branches).
- Heuristic (organization with new functional focuses).
- Purposeful (organizations with new institutional roles).

Finally Martinelli himself proposes the following types of systems:

- Non-systems or those with random interactions (for instance, hit-or-miss business, Kipling's happy-go-lucky railway).
- Static, which are rigidly defined (for instance, factory buildings, layouts machines).
- Simple dynamic, which are kinematic and rigidly defined (for instance, automated procedures for payrolls and invoices).
- Feedback dynamic with feedback rigidly defined (for instance, the thermostat, Watt's regulator, or stock control).
- Multilevel with subordination and variable feedback (for instance, subway trains control, or organizational roles and organs).
- Autopoietic with self-production identical or similar (for instance, remaking entire organizational sections, franchising).
- Adaptive, with learning capacity and inventing new actions (for instance, mechanical turtle, chess programs, learning organizations).
- Evolutionary or capable of changing the environment (for instance, organizations changing structure and identity for viability).

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Biographical Sketch

Francisco Parra Luna was born in 1937. He studied Economics and Business Administration and worked as Controller and Administrative Director en La Cruz del Campo, S.A., in Seville, and Cerveceras Asociadads, in Barcelona. He has doctorates in Sociology and Political Science from the Universities of Lausanne and Geneve (Switzerland), and the Universidad Complutense of Madrid. He is Catedratico de Sociologia in this University. He created the “Working Group on Systems Theory” in the International Sociological Association” and participated as Chairman of several international meetings. He is a member of several academic associations and belongs of the editorial board of several journals on systems theory and sociology. He has published about fifty scientific articles in professional journals and several books, among them, *Towards Comparing National Social Performances* (University of Lausanne, 1974); *Balance Social y Progreso Empresaria* (Edit. Cirde, Madrid, 1980); *Sistema Sociopolitico y Seguridad Social en España* (Ed. Index, Madrid, 1980); *Los Emigrante en españoles en Francia* (Instituto Esp. de Emigración, Madrid, 1981); *Sociología Industrial y de la Empresa* (written with J. A. Garmendia and M. Navarro, Edit. Aguilar, Madrid, 1987); *Politica de Empleo y Bienestar Social* (Ed. Eudema, Madrid, 1988); *El Balance Social de la Empresa (*Ed. Deusto, Bilbao, 1989); *Sociologia de la Empresa y de los Recursos Humanos* (Taurus, Madrid, 1993); *La Empresa contra si misma* (Ed. Deusto, Bilbao, 1993); *Sustainable Development* (written with J. L. Elohim and E. Stuhler, Rainer Hampp Verlag, Munchen, 2000); and *The Performance of Social Systems* (Kluwer Academic/ Plenum Publishers, New York, 2000).