# From Epistemology to Action

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## Abstract

The central idea of this contribution is that better disciplinary scientific theories, in particular in biology, in ecology, in social and political sciences, in economy, will not suffice to solve the numerous problems that plague modern society. In our opinion, its improvement and transformation into a viable social system will necessitate not only more adequate theories but also a deep metamorphosis of our way of decoding the word. In this paper we engage in some reflexions on the ontological and epistemological foundations of the mainstream mechanist sciences, and propose some systems inspired extensions in order to be able to understand also the complex and autonomous systems.

## Résumé

L'idée centrale de cette contribution est que de meilleures theories scientifiques disciplinaires, en particulier en biologie, en écologie, en sciences sociales et politiques, en économie ne suffiront pas pour résoudre les nombreux problèmes qui affectent la société moderne. A notre avis, l'amélioration de la société et sa transformation en un système social viable, n'exige pas seulement des théories plus pertinentes mais également une profonde métamorphose de notre façon de décoder le monde. Nous nous livrons donc dans cette contribution à quelques réflexions sur les fondements ontologiques et épistémologiques de la science mecaniste dominante et nous proposons quelques extensions d'inspiration systémique afin d'être capables de comprendre également les systèmes complexes en voie d'autonomisation.

## 1. Introduction and Summary

It is becoming evident, even for the most convinced adepts of the mainstream scientific paradigm – based on the Newtonian mechanist dynamics, the Cartesian dualist and reductionist approach and the Aristotelian binary non contradictory logic - that we have been living, in the last few decades, a growing accumulation of unexpected events and problems. They appear mainly at the interface between the logic of economy and politics, the aspirations of man and the ecology of the environment. Such developments raise questions not only about science but also about the adequacy of our worldview. Some analysts even claim that no pertinent theoretical and no epistemological frameworks are available any more to interpret the accelerating evolution of the Western techno-economical society during the last few decades.

Broadly speaking, on a more pragmatic level, three types of reactions to this situation can be observed:

1. "More of the same". The so called liberal[1] interpretation, according to which the socio-economical system of which we are a part is basically just; the negative points are mere unintended momentary consequences of an otherwise beneficent machinery. A little reform here, a little money there should solve the problems.

2. "Mutation". The so-called radicals believe that the system is the problem. The inequities between haves and have-nots are inherent to this profit-based competitive system and even required by it, in order to function. In this view, the existence of poor and unemployed people is not the consequence of the system breaking down but, on the contrary, is inherent to its own good functioning.

3. "Nostalgy". Conservatives and integrists are nostalgic of the old models of society: agrarian-type stable organizations accompanied by strong religious beliefs, hierarchical social classes and unquestionable nationalistic or ethnic identities.

In our contribution, we would like to go beyond the usual specialized disciplinary interpretations based on economical, political, sociological or psychological conceptual frameworks. In the search for better means to interpret and manage modern society, we are looking for other recommendations that could be deduced from a more panoramic view of nature, in particular of the complex self-organizing systems that have emerged and evolved on planet Earth, and of which societies are examples.

Human societies, on one hand, belong to the long continuous terrestrial evolution that is characterized by the successive complexifications of physical, chemical, biological, organic and societal entities. In that respect, human systems share common features with the other complex natural systems: thermodynamical principles, physico-chemical reaction processes, non linear dynamics, cybernetical organizational constraints and potentialities, are rules respected by all kinds of systems.

But, on the other hand, on their way to increased complexity, systems acquire new properties through the phenomenon of emergence. Self-organization, self-production, self-reference, are features that appear only beyond some threshold of complexity and are therefore not understandable by the usual mechanistic natural sciences.

Such necessary extension of science requires not only new theories and new formal tools – like non linear dynamics, chaos theory, fractals, cellular automata, cybernetical networks, etc. - but also, in our opinion, invites us to question the usual epistemological and ontological presuppositions.

In summary, it seems to us that no substantial improvement of our capacity to manage society and prevent dangerous drifts can be reached without

1. improving our understanding of the dynamics of complex autonomous systems (i.e. theories)
2. change the language used to decode nature (i.e. epistemology) as well as our beliefs about the deep nature of the universe (ontology).

In the continuation of the present contribution, after recalling some recent examples of unexpected problems in the history of modern society, we will describe an alternative metamodel where reality is not reduced to matter (in space and time), like in the Newtonian mechanist worldview, but includes relations on an equal footing with matter. We will also try

[1] in the American sense of the word

to show how a third, and most important primordial category, existence or whole, emerges from objects and relations.

We will then deduce from our general onto-epistemological metamodel, "the rules of the game", i.e. the main features of the dynamics of complex systems, as they are manifest in most terrestrial systems: ecological, sociological, economical, cultural, and so on. This review of the functioning and evolution of complex systems will be followed by some principles of action that should be respected by those who want to manage the systems around us. We end the paper by describing in more details a particular method that analyses the different levels of intervention in a complex societal system.

## 2. Diagnosis: What went wrong in Western Societies ?

If we examine the main trends in the history of Western society since World War II, we notice an ambivalent evolution. On one hand, several developements can be qualified of progresses since, broadlly speaking, they resulted in an improvement of the quality of life for a large proportion of the population. But, on the other hand, several simultaneous developements must rather be qualified of negative collateral effects, since they disturbed the quality of life, the liberty and the expectations of large segments of the population. Let us have a closer look at these two trends and try to analyse the reasons for this double evolution.

<u>Progresses</u>

Most "progresses" in the last two centuries took place in the field of science and technology. Here is a short list of the main points:

- <u>Energy</u>: Usage of fossil, renewable, and nuclear resources liberated man of hard work.
- <u>Materials</u>: Extraction, transformation and production of devices and goods improved material well being.
- <u>Transportation</u>: Transport networks increased human mobility.
- <u>Communication</u>: Wire and wireless communication networks multiplies information exchanges between men and between men and machines.
- <u>Data handling</u>: Computers and computer networks liberates men from routine mental work.
- <u>Biology and medicine</u>: Progress in these fields improved health and prolonged life.

<u>Problems</u>

Problems concentrate mainly in ecology, in economy, in societal and hybrid global systems. Here is a very partial list of such problems:

- <u>Ecology and biology</u>: atmospheric and climate modifications ($CO_2$, ozone hole, smog and other pollutions). Soil erosion and degradation. Underground water pollution. Chemical and radioactive waste management. Loss of animal and vegetal biodiversity. Impact of bio- and genetic technologies. Degradation of human health: respiratory and alimentary pathologies (obesity), cancer, etc.
- <u>Psycho-social field</u>: psychiatric and psychosomatic disorders (mobbing, etc.), toxicomany and alienation, racism and intolerance, violence and criminality increase in some parts of society,

- Hybrid global economico-political system:
  - Fall of the planned economy systems (URSS, etc.)
  - Fascistoïd drift of some democratic states (USA, UK?,)
  - Debt of public institutions (states, provinces, etc.)
  - Inequitable allocation of wealth by the globalization of the market system within and between countries
  - Terrorists-type movements against some rich Western countries
  - Privatization of common goods
  - Lack of conceptual models to interpret the observed evolution

Diagnosis: Comparision between Progresses and Problems

As we have seen, most "progresses" belong to the field of technology; they concern mainly the manipulation of inorganic simple materials (mineral materials, often metal), i.e. isolated or separable objects, eventually complicated[2] devices like a complicated watch or even a nuclear power plant; these agregates can be decomposed into separate components. Such situations can therefore be studied by reductionist approaches, as is often the case in linear material sciences like physics or chemistry.

In summary, progresses have been performed in cases where the material aspects of things is dominant and with configurations that can be analyzed by decomposition into simpler parts, and therefore by controlled.

Problems, on the contrary, belong mainly to the fields of biology, ecology, economy, sociology, politics, psychology. In other words, they are present, not in complicated situations which can always be analyzed in terms of simpler components, but sit in complex interdependent configurations which, by their nature, must be studied as wholes. The most significative features of complex systems are holistic caracteristics, which do not come from some component or the other, but emerge from the collective cooperative effects of several parts of the system. Significative properties of complex systems, like self-organization, or morphogenesis, self-regulation, life, consciousness, are synergetic properties emerging for the collective effects of several processes within the system. New conceptual tools are therefore necessary to interpret such situations.

In summary, the "problems" in our society, beside their structural-material aspects, should be studied with particular emphasis

- on their relational aspects, the organization of the concerned networks of interactions
- on the new holistic aspects emerging from their complexification
- on balancing the analytical prospection of their internal structure-organization and the study of their place within the larger context, i.e. the Umwelt in which they are.

## 3. Proposal of a Non-Disciplinary Metamodel for Complex Systems

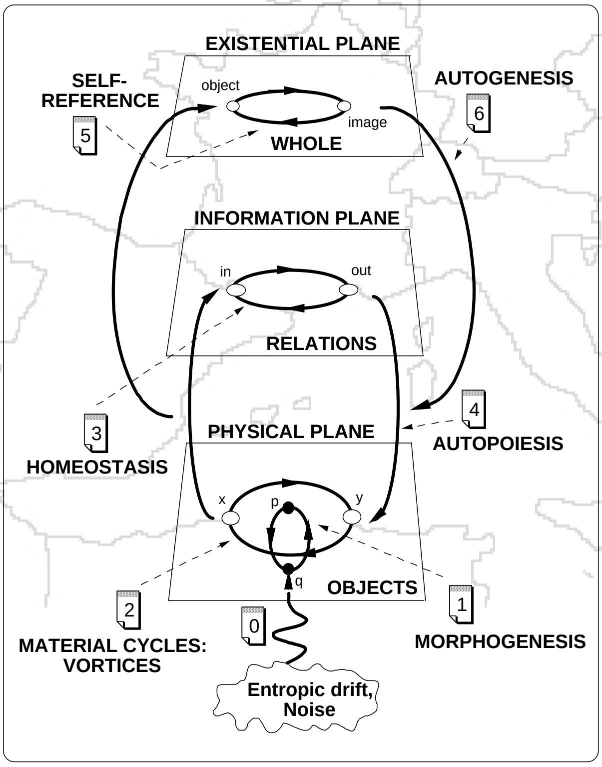
[2] a complicated device is a simple addition of separable preexistent components, whereas a complex system is made out of a large number of components interconnected by a dense network of relations, in such a way that a modification somewhere in the system modifies the whole system.

Our metamodel has been presented in more details elsewhere (SCHWARZ, 1997), we will therefore mention here only the main points.

Historically, it has been inspired by three branches of the systems movement and three crucial concepts:

1) The first one is the idea of system, as promoted by Ludwig von Bertalanffy (BERTALANFFY, 1968), (HAMMOND, 2003). A system is an undivisible entity (although its internal structure can or even must be prospected), with emergent holistic properties whose nature cannot be expressed in terms of those of the parts or of the relations.
2) The second new non-physicalist primal category is that of relation, metaphorically introduced in cybernetics as a black box signalled by an input/output correlation. (WIENER, 1945). Before the advent of cybernetics, a relation was usually expressed in natural sciences as a physical entity like a force, a field or an exchange of quanta.
3) The third important non-mechanist concept is a particular type of relation with a holistic aspect, the circular causal loop, or self-reference, in its many instantiations: self-organization, self-regulation, self-production. The latter, also called autopoïesis, has been proposed as the logic of self-productive living systems by Varela. (VARELA, 1989).

To integrate these systemic concepts and others, we have proposed a synthetic transdisciplinary model to help interpret the emergence, the evolution and the functioning of self-organizing natural viable systems of any kind: physical, biological, social, or cognitive (SCHWARZ, 1997, 2002).




Crudely speaking, in this meta-materialist and non-dualist approach, the world is not seen as objects moving in space and time according to permanent laws, as in the mechanist sciences, but rather as made of networks of interconnected entities called systems. The most simple (or degenerate) of them can be approximated by the usual mechanist approach, but the normal, complete ones (see left fig.), the complex and operationally closed systems are described as wholes (reprsented in the existential plane) emerging from a permanent ontological dialogue between their structure (in the physical plane) and their logical organization (in the information plane).

Viable systems are characterized by three cycles giving stability: physical vortices (recycling of matter, 2), functional feedback loops (homeostasis, 3) and existential self-reference (5). Three cycles are responsible for the changes that insure the perennity of the system in face of unexpected events: physical self-organization (morphogenesis, 1), self-production of living organisms (autopoïesis, 4) and self-creation (autogenesis, 6), the cycle that leads to autonomy.

This meta-model is specially pertinent to interpret systems which are complex (with dense causality networks) and relatively autonomous (with strong self-referential character); typical examples are living systems, social systems and cognitive systems.

More details can be found in the references.quoted above.

## 4. Consequences I: Rules of the Game, the Dynamics of Complex Systems in Nature

As we have claimed from the start, the main purpose of this paper is discuss ways to intervene in complex systems, in particular in ecolo-socio-economical systems, of which we are a part. Our strategy is first to understand the dynamics proper to natural systems and, from there, to extract some efficient principles of action, and eventually concrete methods of intervention.

In section 3 we have presented the main features of a non mechanist non dualist metamodel, or language,

- to interpret complex systems on their way to autonomy and
- to identify the common dynamical behavior of such systems.

In the present section we list the main "rules of the game", by which we mean the common dynamical caracteristics of this type of systems. Due to the lack of room in this paper, we cannot go into the details of these rules and will only mention the most important ones.

- Nature. Nature, including ecological, human and social systems, is constituted of organized dynamical non-permanent wholes composed of interacting parts, which are called systems.
- Origin. Natural systems form by themselves, in reaction to tensions with their environment: the primordial origin of order is noise and self-organization.
- Morphogenesis. Order emerges in the form of two opposed and complementary processes: differentiation and integration.
- Interdependencies. The systems of nature are interdependent entities integrated in the networks of nature. Anything may change anything else, (or everything).
- Holarchies. Every system (a holon) is composed of sub-systems (holons) and can combine with others to form super-systems. Nature has therefore a fractal-type structure of holons of holons of holons.
- Dynamics. Changes in systems are caused by three types of causes:
    - No-cause: noise, fluctuations
    - Entropic drift: trend toward the thermodynamically more probable (maximum of entropy), Popper's Propension.
    - Circular causality: auto-organization, auto-regulation, auto-production, auto-reference, auto-genesis
- Short term change: conflicts. Conflicts belong to the normal rules of the game. Conflicts between two systems can lead to three types of outcomes:
    - Return to the configuration as it was before the conflict, eventually with some slight corrections (Bateson type 1 change)
    - Metamorphosis: deep change of the whole configuration including the agents in conflict (Bateson type 2 change)
    - Destruction: regression or destructuration of one or both conflicting agents
- Long term change: evolution. The long term evolution in nature is not pre-determined but results from the accumulation of the local and short term changes that are able to survive and are due to dissipation, conflicts and/or spontaneous self-organization feedback loops.

- Survival: On the long run, systems that have survived numerous conflicts and dissipation, despite the large probability to disapear, can acquire, through this very experience, structural, organizational and holistic characteristics which improve their viability. In other words, they learn to survive, or more philosophically, they learn to be.
- Viability: This "apprenticeship of life" favors processes that favor survival. In particular:
  - On the structural level (physical plane of the metamodel), complexification seems to favor the capacity to increase the number of survival strategies of the system.
  - On the organizational level, circular logics (self-reference), like self-regulation, self-organization, self-production (autopoiesis), helps the system to resist the omnipresent dissipative increase of entropy.
  - On the existential level, emerging holistic features like cognition, identity, consciousness also increase the ability of complex organisms to be less dependent of the blind laws of matter like physics, chemistry and even biology.

## 5. Consequences II: Principles for Action, mainly for Human Systems.

Before discussing in the next section a specific typology of interventions in complex systems, we would like to mention a short list of simple and general principles that should not be forgotten when studying complex systems with a strong human dimension, like social, political, religious, or economical systems. Such systems are so close to our daily life and so loaded with beliefs, ideologies or interests, that we often forget the usual precautions that are common in the more neutral natural sciences.

- Human systems are natural systems with systemic properties. Individuals, as members of the system, of course influence it, but the system is not a logical and conscious construction of human minds like a house or a computer. A social system has collective, holistic features of its own which may not be controlable. Spin doctors can manipulate, but their power is limited, and sometimes the system gets out of hands.
- Observers are part of the system they observe. As mentioned above, self-reference is an important property of viable systems. The viability of our society could therefore be improved if our image of ourselves corresponds to the actual causal network at work in the society of which we are members.
- Self-production. Very self-referential systems can be self-productive (autopoietic), like living systems. Is modern society self-productive ? Is the explosion of economy and finance a stage in the evolution of a viable society or does it correspond to the cancerous proliferation of some agents at the expense of others ? More research should clearly be done along these lines.
- Viability. As we have seen, besides autopoiesis, the viability of complex systems depends on the presence of three stabilizing cycles (recycling of materials, self-regulation, self-reference) and three change producing cycles (self-organization (morphogenesis), self-production (autopoiesis), and self-creation (autogenesis)). The search for the presence of these six circular processes could be a guideline to estimate the degree of viability of the present social organization.

Let us repeat that the viability of society is improved if it has a global image of itself more pertinent than the multiple partial models of the specialized disciplines. Research and education in the field of systems science should be strongly supported. Object thinking should be completed by systems and network thinking. Awareness of holistic features and existential categories should be propagated, along with ethical and spiritual reflection and training.

We conclude this contribution by discribing the main features of a systemic method that reviews different ways a complex system can be influenced.

## 6. Consequences III: A Systemic Methodology for Intervention in Complex Situations

We will finish this paper "From Epistemology to Action" by showing the correlation, which may look somewhat abstract and far from daily reality.

Donella Meadows (1946-2001) is a coauthor of the famous Report of the Club of Rome, "The Limits to Growth" published in 1972, just one year before the first energy crisis (MEADOWS, 1972). She later published a very apreciated study on the management of systems called "Places to Intervene in a System. (MEADOWS, 1997).

Meadows start with the observation that there are places, or levers, within complex systems (such as a firm, a city, an economy or an ecosystem) where a small and local action or pressure can produce big changes elsewhere in the system. She claims we not only need to realize the existence of these leverage points, but also to know where they are and how to use them. The understanding of these leverage points would be powerful information to solve major global problems such as unemployment, hunger, economic stagnation, pollution, resources depletion, and conservation issues.

She considers essentially the material and cybernetical aspects of systems (energy and matter stocks and fluxes, feedback loops) but her hierarchy of levels can very well be integrated, interpreted and understood in our more general three-planes and six-cycles holistic metamodel.

In her analysis she identifies 12 leverage points, from the most frequently used - which also happen to be the less efficient – to the most efficient but are also the most difficult to implement.

Let us list these 12 levels and place them in our general three-plane pattern for complex systems (see the figure above).

A. Intervention points situated mainly in the physical plane of systems:
   - 1, Constants, parameters, numbers. (Examples: taxes, subsidies, norms). Parameters are points of lowest leverage effects. Though they are the most clearly perceived among all leverages, they have little effect on the long term; they do not usually change behaviors. A widely changing system will not be made stable by a change of parameter, nor will a stagnant one dramatically change.
   - 2. Buffers or other stabilizing stocks. (Example: oil radiator as stock of heat to be used when needed). A buffer is a reservoir that can regulate variations of fluxes

- 3. Structure of stocks and flow circuitry. The structure of the system may have enormous effect on how the system operates. So it might also be a leverage point on which to act.

B. Intervention points situated mainly in the relational plane of systems:

- 4. The strength of negative feedback loops. A negative feedback loop is a control that tends to stabilize a process. The loop will keep some value near the goal, thanks to parameters, accuracy and speed of information feedback.
- 5. A positive feedback loop is a control that tends to speed up or slow down a process (it refers to the direction of the change). It is a self-reinforcing loop. Positive feedback loop are sources of growth, of explosion, and sometimes of collapse when the feedback is not under control (in particular of a negative feedback loop).
- 6. Information flow is a very important leverage point in a human system. It is neither a parameter, nor a re-inforcing or slowing loop, but a new relationship(immaterial) delivering information which was not delivered before. It is considered a very powerful leverage, cheaper and easier than infrastructure change.

C. Holistic features corresponding to the existential level of the system. By definition, the existential dimension of a system reflects its global state. It belongs to the system as an identity and emerges from the totality of its physical structure and of its relational organization. Strictly speaking, the existential status of a system cannot be manipulated at will like its material structure or its cybernetical network, as was shown in points 1-6 above. Of course an outside action can resonate in a system, but the outcome of this resonance depends more of the history, the structure and the pattern of its internal organization than of the intentions of the manager. Nevertheless somebody who has a good knowledge of complex systems and their dynamics can be more successful in inflence them than a mechanist expert. We will therefore mention now Meadows suggestions for these subtle interventions:

- 7. The social rules of the system such as incentives, punishment or constraints. Rules are very high leverage points. Meadows points out the importance of paying attention to rules, and mostly to who make them.
- 8. The power to make the system change, evolve, or self-organize. Self-organization refers to the capacity of a system to change itself by creating new structures, adding new negative and positive feedback loops, promoting new information flows, making new rules.
- 9. The goal of the system. Such a change has an effect on all the above points.
- 10. The mindset or paradigm. A society paradigm is an idea, an unstated assumption (because it is unnecessary to state it) that everyone shares. Any set of assumptions becomes a paradigm, and therefore re-examining all the fundamental assumptions may lead to new paradigms. Paradigms are very hard to change, but there are no limits to paradigm change. It just requires another way of seeing things.
- 11. Transcend paradigms. To illustrate this last point, let us distinguish three levels of awareness. The first is to have beliefs, and think they are the truth; they are the only way to understand the world; these beliefs can be religious or paradigmatic (the empirico-rationalist paradigm for example). A second level is to know that we see the world through a particular paradigm and be aware that there are other ones. The third level is reached when we ask ourselves what is a paradigm. Is it necessary to have one ? Is it not possible to see the world as it is ?

## 7. Final Remarks

We have shown that understanding our natural and social environment as well as ourselves requires a deep transformation of science. We have tried to show that ontological and epistemological questions are not only entertainment for closet philosophers but are vital for the future of human society. We hope that the systems approach will help in this crucial enterprise.

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