SYSTEM, INPUT, OUTPUT:
A CRITIQUE OF SCIENCE FROM THE STANDPOINT OF WASTE

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ABSTRACT

In this paper it is not so much about the epistemology of waste, but about the epistemology of science from the standpoint of the system theory. Although science meant from its beginning the search for causes and correlations – thus necessarily considering the systems it has focused on – its modern history presents rather a kind of dialectic of holistic and fragmentary approach. In other words, the inherent analytical approach in the construction of scientific theories, the deepening of the professional character of science and special disciplines have seemed to leading to the separation of the *main* results from the aggregate of results and phenomena. No one has aimed at discussing the residual/secondary phenomena, because what seemed to be respectable in the scientific research was the correlation between the laws or regularities, emphasised through difficult measuring and arguments, and the *main* phenomena "reflecting" the laws or regularities and targeted and pursued by the scientists.

As we know, the accumulation of data, information and aimed theories emphasises the shortcomings and contradictions in the given corpus of science. At the same time, the coherence of theories is confronted with the real phenomena, irrespective here of the definitions we forge for "reality". In the middle of the last century, the current of the *integration* of fragmentary theories related to the sub-systems targeted by scientists into a *general system theory* has appeared and, obviously, has shaped the scientific outlook on the world, with all the inertial continuation of fragmentary research.

Nevertheless, the systemic tackling had – and still has – a serious deficiency: the much weaker attention to the residual/"unintentional" results. But the thesis of the paper is that this deficiency is not so much generated by the internal logic of science than by the extra science logic of *decision-makers who control science*. Illustrating this thesis, the scientific view of Aristotle-Ludwig von Bertalanffy line is counter-posed to the present distortion of the real world full of all kinds of waste. The epistemological conclusion is that the problem of waste/consequences imposes the re-thinking and transformation of the whole model of *input-processing-output* system.

KEYWORDS: science, waste, system, system theory, Aristotle, Ludwig von Bertalanffy, Jevons paradox.

Warning

Although the problems of waste – as a *consequence* of human activities – are huge and, actually, they are not developed in this paper, one starts just by pointing out some aspects of this challenging concept (and reality). The introductory note about waste intends to emphasise the necessity of systemic approach and thus, of a lucid epistemology of waste.

However, the thesis of this article is that, although the modern science has always considered the *consequences* of both its findings and the functioning of the systems it analysed, *the exterior frame of science has used this judgement on consequences only according to the interests manifested at the level of this frame*. As a result, science itself has developed in research programmes which seemed to neglecting the systemic approach it has contained in its logic, and thus to exaggerating its inherent focus on fragments of objects/reality (irrespective of what it called as reality).

Concretely, the paper emphasises Aristotle's tradition, his *systemic* approach and inherent warning about consequences and, besides the pointing of the evolution of this type of tackling, its features are mentioned. These features are those of the *input* quantities/domains, the *output* quantities/domains and the *internal processing* of the input quantities by the system. As it is known today, this third element is "the black box" between what is seen before and after its activity.

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In their turn, the output quantities are twofold: the *targeted* output and the secondary/*residual* output. What this residual output does mean is showed by relating the logic of systems with the modern *general system theory* (Ludwig von Bertalanffy) and the present state of things in the world. The question explicitly answered in the paper is why, since the main ideas of the systemic approach were substantiated, these ideas were not really introduced / applied in the human environment. Therefore, this message *of sociology of science* is transmitted after scientific demonstrations concerning various systems and historical stops.

Waste and its understanding

Waste/ detritus/ debris/ remnants/ garbage/ trash/ manure/ scum/ dirt/ dung/ muck/ dregs/ flotsam and jetsam/ scraps/ leavings/ sweepings/ dross: all of these synonyms show that there are, obviously, different types of waste, with *natural* and *artificial* origin and *able, or not, to be absorbed by and melted/decomposed in the environment* that surrounds the system that produced it. But with all differences, what is common to the types of waste is their characteristic to be *output* quantities, and *secondary* or *un-necessary* output from the viewpoint of the system that made them.

The Latin origin of "residue" is *residuum*, from the verb *rĕsīdo, īdĕre*, or *rĕ-sĭdeo*, *sēdi* to lay, to stay, to remain, or to stop. Indeed, the output *targeted* by humans "does not remain", because it is used in different ways and transformed. For humans – warned by the ontological *scarcity*[2] – the desirable output was always scant, while what they did not need was dragging.

From the above enumeration of forms of waste, another cardinal feature of waste appears: that it is the result of a *living* and, more, of an *anthropogenic* living system's relations with its environment. In the *inorganic* matter, all the results of clashes and transformations have "equal dignity": the model of relations in the inorganic matter does not emphasise the problem of garbage. Every secondary result is also *integrated* in the surrounding environment and is subject of further transformations. All the results of the inorganic systems are conditions for the continuous manifestation of relations/interactions and movements: obviously, beyond a certain threshold, determined by the physical and chemical laws, the relations from the inorganic world change, the inorganic forms change, but nothing is expelled *as if* it would be an unnecessary and harmful substance.

Waste appears in the living world, but it is *integrated* in the functioning of the broader systems, *as if* it would be about the inorganic world. In fact, the most inclusive system, *nature*, is here the *inorganic* world *plus* the *living* one, but *without the human being*. The two sub-systems of nature help themselves mutually in order to annihilate waste: since the living systems are those based on exchange of matter, energy and information with the surrounding environment, they not only take matter etc. from the milieu, but also overflow their surplus, generating at both ends of the living process: 1) local imbalances in the inorganic world, which are the basis of new transformations in this world, and 2) organic matter, energy and information possible to be used in *other* organic/living processes, rather at inferior or superior levels than that of the living system that produces the given waste. Thus, nothing is waste in the natural world, because everything is transformed and used in natural processes.

One thus may conclude that the inexistence of waste in the inorganic world is determined by two facts. The first is that the inorganic world is only one system: obviously, there are sub-systems, systems in systems, constituted through the locality of interdependencies/relationships, but the subsystems may transform without the annihilation of the relationships of the inclusive system; all

[2] Jean-Paul Sartre, *Critique de la raison dialectique (précédé de Questions de méthode), Tome I, Théorie des ensembles pratiques*, Paris, Gallimard, 1960.

the results of transformations of the sub-systems are principal. The second fact is that in the inorganic world there is no "*principium individuationis*"; I borrowed this term from Schopenhauer – where it meant the form of possible knowledge of an individual[3] – but I use it as principle of the possibility of division within the living matter just because only in this way the living structures and relationships may last and evolve. The difference between the inorganic and the organic is that, while the inorganic matter may divide/ a sub-system may transform without the disappearance of the elements and constitutive relations, the destruction of the living system means the disappearance of bio-chemical substances and reactions, possible only within the frame of that organism. *Principium individuationis* means complexification of matter; or, the complexification of matter is possible only through the *principium individuationis*.

The problem of waste occurs with the human being. This specific being is a living one, but its waste can no longer be melted in nature. Why? Because: the human is, ontologically/ from its first moments, "artificial" – i.e. cultural –, thus having a "natural artificiality"[4]. The waste produced by humans is the result of their *cultural* activities, viz. of their *development* of life *beyond* the shortage that is an ontological condition of the animals' life and has as outcome their individual untimely death and their living under the sign of chance and adaptation to the exterior conditions. The humans have an individual control over the exterior conditions of life only because they are *social* beings and have a social control over the exterior conditions of life. Their adaptation to the exterior conditions *follows* their capacity of anticipation, of being Prometheus/beings who think and model in advance the situations and facts.

The cultural development of human animals has taken place under the sign of production/ transformation of the exterior conditions of life. Once they have arrived to a certain consciousness of their being within the existence/the exterior conditions of life, they have understood their appurtenance to the surrounding nature and the importance of the exterior conditions and of their activity's results. There is no here the place to elaborate on this topic. What has to be underlined is that, obviously, they have focused on the *intended fruits* of their activities. Accordingly, because of the paucity of the human communities and thus because of the melting of their waste in the environment, they were not preoccupied about their natural and artificial unintended waste. When the communities have concentrated, or cities have been constructed, the humans have developed systems of public water supply (this means interest for input) and sewage, drainage and wastewater systems (these are output), actually related to each other[5]. But the representations of the ancients were a *mixture* between the *celebration of holism* and, on the other hand, *ignorance of the effects of human activities*: the intensive deforestation of forests and land for agriculture, or the extension of mines[6] were the clear sign of the inherent *priority of inputs on outputs*, related to the realistic understanding of the material determination of man, irrespective of its spiritual peculiarity[7].

[3] Arthur Schopenhauer, *The World as Will and Idea* (1818/enlarged in 1844), Seventh Edition, Translated by R.B. Haldane and J. Kemp, Vol. 1, London, Kegan Paul, Trench, Trübner and Co, 1909, p. 336.

[4] This is as so many thinkers have underlined: starting with the ancients and till today; or, here, from Aristotle, via Marx who has *demonstrated* why, to the contemporary writers. Helmuth Plessner is one of them; see Jos De Mul, "Artificial by Nature. An Introduction to Plessner's Philosophical Anthropology", in Jos De Mul (ed.), *Artificial by Nature. Plessner's Philosophical Anthropology: Perspectives and Prospects*, Amsterdam University Press, Amsterdam 2014, pp. 11-37.

[5] A. N. Angelakis, J. B. Rose (Eds.), *Evolution of Sanitation and Wastewater Technologies through the Centuries*, London, IWA Publishing, 2014.

[6] See Xenophon, *On Revenues*, Translated by H.G. Dakyns, IV.

[7] Aristotle, "Nichomachean Ethics", *Aristotle in 23 Volumes*, Vol. 19, translated by H. Rackham. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd. 1934: I, 8, 1099a15: "not easy, to play a noble part unless furnished with the necessary equipment"; X, 7, 1177a4: "the wise man equally with the just man and the rest requires the necessaries of life".

However, we must not ignore that all the developments of knowledge, conceptions and technologies have taken place within the concrete *social frame* of power/domination-submission relations. We cannot discuss those developments separately from the social history.

Therefore, when analysing the problem of systemic approach and sensitivity towards unintended/secondary products, we have to consider *both the epistemological conditions and the social ones*.

Thus, we cannot neglect that the rhythm of creation of waste, the incredible ignorance of systemic interdependencies and the results considered only in short-term sight were related not simply to the first industrial revolution – as fever of technological inventiveness aiming only to achieving the desired result, without being overwhelmed by the collateral consequences – but to this revolution waged in capitalism. The unconcern towards the effects on the whole (social and natural) system was not a simple manifestation of the priority given to the specific technological goals pursued by enthusiastic scientists and inventors, but the form through which capitalism has channelled the cognitive and practical interests to inputs and *main* outputs. The structural reason of this type of channelling was the private property aiming at maximising the profits realised through the main outputs it pursued, and thus aiming at externalising the costs of the undesired outputs. For this reason, the private property has supported the development of particular systems' tackling, and has brought out from the general social consciousness the interdependencies and correlations of these particular systems in the frame of a unique system.

Consequently, the cognitive treatment of waste is intertwined with the systemic representations, it is their main aspects.

The idea of system and the Aristotle moment

First of all, the idea of *system* is older than its concept. It was somewhat tantamount to the idea of the *whole* (*holos*) that, as the *real* whole has appeared to humans, meant *ordered* whole (*kosmos*). In the ancient thinking in every corner of the world, the *harmony* (that order/ordered whole) and thus, the *interdependencies* and *intertwining* of all the aspects and elements, were common and top ideas acting as principles warning about the limits of things and humans' actions.

In the European thinking, Aristotle was the pioneer who systematically has deployed not only the holistic approach, but also that of the input-output quantities as something different from the system, but determinant for it. The model of Aristotle was the *living being*, the *organism*. This special being was not only emblematic for the (understanding of) *purposes* it bore and had in its inner constitution/logic (the *telos* or *conatus* of the living being, and the *teloi* of its parts), but also for the *open* character of the living systems and, thus, of the *exchanges* of these systems with their environment.

Obviously, for Aristotle – as for every scientist – what was the most important was the system as such on which he focused on, and not its relations with the environment, but the analysis has put him into evidence that even what occurs inside the organism, the internal interdependencies showing the "laws" of the constitution of the system (the formal and final causes) – that "nature does nothing in vain" and "always does what is best", applying the principles of economy, compensation and specialisation[8], the forms of animals witnessing the scale of animals' perfection – are *related to the whole environment* where the being lives. *The animals fit to their environment*.

Consequently, the Aristotle's model of organism was an *individual* system, relatively *autonomous*, but *open*, i.e. in matter, energy, information *exchange relations* with the environment.

[8] Milana Tasić, "On the Classification of Animals According to Biological Functions, After Aristotle", *Biocosmology – Neo-Aristotelism*, Vol. 7, No. 3&4, 2017, pp. 513-523.

Why do these relations occur? Because: the end of the organism is its *self-preservation* or *integrity* or a *stable functioning*. This means that the organism takes over from the environment the matter, energy and information it needs, and certainly, the non-necessary / surplus matter and energy is expulsed / evacuated by the organism in the same environment.

We talk about a model; obviously, Aristotle did not concern about the dung of animals, but this aspect was nevertheless essential in their metabolism. As well as the information processing – through sense organs to the heart[9] and back (to see, hear etc. again) – involved not only inputs but also outputs. And in general, the organisms' matter, energy and information exchanges are *integrated* in the surrounding nature, and are *not harmful*. Even the expulsed matter and energy may be *re-used*. And there is – but this is rather an implicit conclusion – always a *threshold* above which the exchange as such does not function, generating changes within the internal system[10].

Assuming the model of organism, Aristotle could discuss the philosophical concepts (the four causes, potentiality, actuality, *entelecheia*) starting in fact from examples related to living beings and humans. The explanation of these concepts really could not have taken place on the basis of inorganic systems: because his intention was to explain nature (*physis*), that is like a living system (open etc.), and not like a collection of stones "revealing" some absolute physical laws. Certainly, the core epistemological concept for Aristotle was the *cause*, and not the *law*, but the fact that *the superior system is better explaining the inferior one* – even if one knows that things begin with the simplest – was a valuable, though involuntarily created[11], epistemological principle brought to light by Aristotle.

Finally, the model of the organism was necessary for the understanding of the *human being*. This one was, obviously, an (individual) organism, but not one simply living in its space and having only – as it was called in the last decades – an *access consciousness* to the environment in order to use this one for its normal functioning, ultimately reflecting the natural will to live (if we may translate the old desire to persist, *conatus*, into the well-known Schopenhauer's formula), but having the qualitative new condition of *social being*, thus developing language, logic, theories and values, thus having a *phenomenological consciousness*. As a result, for Aristotle, the humans had to harmonise the necessities related to the biological aspects of their organisms and the necessary human behaviour according to the understanding of the human peculiarity. In this respect, to the first necessities a *household economy* corresponded, signalling the general economic logic of *use values* exchanges, and thus rather following Plato's warnings against the excesses[12], while the different manifestations of the human/moral level of development had to follow the prudent aim of the golden middle[13]: because this trajectory is possible, since the humans are reasonable and they explain to themselves the reasons and consequences of their facts (as Aristotle himself did, in the *Nicomachean Ethics*). However, Aristotle too was a temperate optimist – leaning more to optimism, than Plato who leant rather to pessimism, in his temperate belief in reason – because he (as Plato did also before) has observed the contradictions of the city, the most advanced stage of the humans'

[9] Not to the brain.

[10] See Aristotle, "On Youth, Old Age, Life and Death, and Respiration", *Parva Naturalia*, Translated by J. I. Beare and G.R.T. Ross, in *The Works of Aristotle*, Under the editorship of W.D. Ross, Oxford, At the Clarendon Press, 1931, Chapters XXIII-XXIV (478b-479a and b), Chapters XXVI-XXVII (479b-480a and b).

[11] Marx was the Aristotelian who even theorised the epistemological principle that the more complex system better explain the simpler one, than the simpler one the more complex one.

[12] Plato, *Gorgias*, 464d, 465a-b, 518c-d; *Republic*, 372a, 372c-d, 373b-c, 373d-e, 425e, 426a.

[13] See Ana Bazac, "Aristotle, the Names of Vices and Virtues: What Is the Criterion of Quantitative Evaluation of the Moral Behaviour?", *Dialogue and Universalism*, Volume 27, Issue 4, 2017, Values and Ideals. Theory and Practice: Part V, 175-188.

coagulation and at the same time a source of extreme behaviours. With extreme consequences: but this aspect was and might be only suggested.

The adventurous avatars[14] of the concept of system in the European thinking

It is obvious that the understanding of systems took place in the coat of the dominant worldviews in each epoch. The European Middle Ages were covered by the religious ideologies and thus even the former original / ancient, popular systemic representations of the world were overlapped by these ideologies. Yes, the world as a unique structure created by God, thus open to His fluxes of leadership and rules, and formed by transitory beings, vulnerable and open too to His domination, may be seen as a common systemic approach. But this general image is not enough in order to speak about a systemic view of people. In that image, the humans did not have the power of relatively autonomous individuals, but rather the position of inorganic stones supporting without opposition the influence of physical phenomena. Obviously, they spoke, ate, toiled, loved and had children, but their instincts signalling them the importance and significances of inputs and outputs in their relationships with the surrounding environment were quelled by the above-mentioned abstract general image. We could formulate this (in Plessner's words about the *positionality* of the living bodies/organisms centred in their own self and living in a certain space – thus having specific relations with the "boundaries" of their own life –): even though the humans lived beyond their physical limits[15], they remained in a very simple state and in a very limited "living beyond their own limits". The reason of the low hygiene of the humans in the European Middle Ages was not, first, the result of low technologies of sanitation etc., but of the religious ideology that *separated the body from the soul*. The focus on the health of the soul has let the care for the body and its relations with the environment in a poorer state than in antiquity. For this reason, the "eccentric positionality" (Plessner), specific to the human being that considers both its "I" and the spatiality created by society – in other words, the "point of view" of the human person –, did not succeed to manifest (even if the humans arrive to a certain equilibrium in their relationships with both the own body and the fellow humans) through the *care for the consequences* of their corporeal existence. And thus, they were neither conscious beings as members of their social milieu. Briefly, the *concrete* systemic approach was not in fashion in that period.

But all of these aspects had to lead – and led – to the constitution of the scientific look about the world, because only this look could exit from the religious ideological frame and criticise the *contradictions* of the medieval civilisation. The modern science has started by being interested just about the systems, the correlations and interdependencies of phenomena.

These systems were cosmological and mechanical; and biological too. But what has connected all of them was the *scientific approach*: i.e. since everything had to be re-thought, the only solution of scientists was to separate the problem/the system interesting for them from the ensemble of problems and the wide system. Every studied problem/system became a "black box", and its external environment, neither as input quantities and nor as output ones, could not yet be considered. But the processes in the system were so difficult to be understood, that the main tenets and schools were those related to these "internal" processes, relating together many internal systems[16].

[14] Here, this term is taken in its figurative sense (starting from the original Indian meaning, as reincarnation) of falling, or unpleasant transformation.

[15] Helmuth Plessner, *Die Stufen des Organischen und der Mensch. Einleitung in die philosophische Anthropologie* (1928), *Gesamelte Schriften*, IV, Frankfurt am Main, Suhrkamp Verlag, 1981.

[16] See for example, the understanding of the material mechanisms in the functioning of living beings: Andreas Vesalius – *De humani corporis fabrica*, 1529, and *De humani corporis fabrica, Libri septem*,1543, emphasizing the anatomo-

Briefly, in the development of modern science two tendencies have evolved: one was *the cropping out of systems from their environment*, while the other was the *enlargement of studied systems with new correlations and sub-systems*. Both tendencies have privileged, after the boundaries of the studied systems were established: 1) the internal structure and functioning, namely the relationships between the elements of the structures of the system, and 2) the relationships between the input quantities and the systems. This *reductionism* was, however, only a temporary – although long lasting – feature of the scientific research. It involved a reductionism applied to the output quantities too; a *twofold reductionism*: after the decomposition of the output in *main*/*desirable* and *secondary*/*undesirable* from the standpoint of the research programme, 1) the ignorance of the problem of disregarded remnants/scrap/tailings/rubbish, and 2) the desirable output quantities – seen exclusively through the target of their increase.

However, these types of reductionism – let say, normal in the 19th century – have continued in the next centuries not because of the neutral inertia of science: for in this case they would have been only temporary, at the first moments of research, and always followed by their surpassing; but only *because of the social frame of science, clearer because of the profit interest of those who control it*.

We may say that *both the systemic approach and reductionism are parts of the logical/cognitive structure*, because they both help the humans to understand the world. They are interdependent, but it we relate the understanding to the *perspective-taking* that is specific to the human uniqueness[17], then it appears that the systemic approach is the end of the fragmentary thinking.

The same can be said about the concepts/meanings of *input* and *output*. They are not only interdependent from the standpoint of the functioning of a system, but also that none of them may be ignored, that is, the complexity of each of them must not be reduced.

Nevertheless, because of the above-mentioned *social* causes, all of these types of reductionism were – and still are – professed.

Well, after the agglomeration of the results of the above-mentioned epistemological strategies, and especially after the evidence of a big number of faulty, harmful, and even intolerable facts in the real world, a new tackling of science started to make room for itself. It was the *general system theory*, whose 20th century's father was Ludwig von Bertalanffy.

There are two aspects which must not be ignored. One is that the holistic, general system ideas already were in the air of the time[18], because in the scientific spirit of their creators the (main)

physiological systems of the human body – and thus being ahead of Copernicus as father of the scientific revolution; as well as Theophrastus Bombastus Paracelsus, with his new therapeutic principle and analysis of illnesses and practical medical methods (books from 1529 to 1536); see Li Runhu, "The Significance of Modern Medical Evolution to Scientific Revolution", *Biocosmology – Neo-Aristotelism*, Vol. 6, No. 2, 2016, pp. 370-376.

Continuing this systemic and material approach: the encyclopaedist physicians Albrecht von Haller (1708–1777), Jean-Jacques Ménuret de Chambaud (1733–1815), and Théophile de Bordeu (1722–1776) reviving Aristotle's theory of organism. See Dominique Boury, "Irritability and Sensibility: Key Concepts in Assessing the Medical Doctrines of Haller and Bordeu", *Science in Context*, Vol. 21, Issue 4, December 2008, pp. 521-535.

[17] Michael Tomasello, *The Cultural Origins of Human Cognition*, Harvard University Press, 1999.

[18] See Alexander Aleksandrovich Bogdanov (1873-1928) with his *Tectology: Universal Organization Science*, 1922 (in Russian), translated into German in 1928 (thus possible source of von Bertalanffy and Norbert Wiener). Or Raymond Ruyer (1902-1987) in *La conscience et le corps*, Paris, F. Alcan, 1937, who definitely stated that one cannot reduce the biological processes to physico-chemical ones, and that the unity and features of the organism explain the development of the superior level of existence, the consciousness.

But already at the end of the 19th century: P. Krapotkin (P. Kropotkin), "On the Teaching of Physiography", *Geographical Journal*, Vol. 2, No. 4 (Oct., 1893), pp. 350-359.

cause of the fragmented character of both science and its results was just the existing level of fragmented scientific knowledge. Anyway, in order to improve the human practice, one needs a new and better perspective of science.

The other is that in general the scientists consider the respectability of their theories according to the efficacy of theories to explain things independent from the social frame/constraints. Ludwig von Bertalanffy was only half the representative of this point of view. Clearer, his inferences generating the general system theory have determined him not only to apply the systemic approach in (the understanding of) society, as in other non-social domains, but also to suggest that the neglecting of this approach in society has irrational consequences.

Substantiation of the general systemic approach and the Ludwig von Bertalanffy moment

Von Bertalanffy, trained as a biologist too, has arrived to his epistemologically superior level of understanding the systems as intertwined, from his "organismic" outlook. In other words, he started from the model of *life*, thus of *organism*, in order to explain different other systems. (But the models of life and organism which came after the first decades of the 20th century already benefited from the theories of organisms within their environments[19]).

The general system theory was the result of former studies related to life, written during the WWII and immediately after. As a theoretical biologist, he could have remained at the deciphering of biological processes. But the post-war scientific upsurge and the evidence of so many real problems taken place even in that welfare state period have pushed him to synthesise some conclusions related to the manners of fragmentary research and view on existence.

The beautiful book published in 1968, *General System Theory*, provides proofs for the general features and principles of different systems and the necessity to approach them in a *unitary* way.

First of all, the general system theory (GST) considers the *inorganic*, the *living* and the *anthropogenic* systems. But how could one unite so different epistemological and real constituents? Consequently, the first main problem is the explanation of the *differences* between systems. There is, certainly, a difference between the *model* of systems and the *real* systems, but what is more interesting is the difference between the *closed* and *open* systems. The living and anthropogenic systems are open.

Therefore, what are important are the *relations* of a system with its *environment*. The system and its environment become equally important in the GST, while in the traditional science what was important was the system. The model taken into account by GST is thus

Input-System-Output.

But we did not forget that the relations of the system are *matter*, *energy*, *information exchange relations*. Thus, through these relations the open system becomes negentropic (with negative entropy) / with an internal beneficial and necessary disorder; by expelling matter, energy and information, the system externalises the unnecessary/too much disorder in the environment. In this way, the system becomes more balanced, but in state of maximum entropy, in permanent openness in the environment, and it may better adapt to the external conditions. But this entire

And before, Marx. For the understanding of the Marxian approach of man animal difference, of mind-body system, man as nature and culture, and ecology, see Joseph Fracchia, "Organisms and Objectifications: A Historical-Materialist Inquiry into the 'Human and Animal'", *Monthly Review*, Vol. 68, Issue 10, 2017.

[19] Von Bertalanffy knew and assumed von Uexküll's theories (he quoted him).

endeavour shows that without internal beneficial disorder, there is no life[20]. (There is a clear difference between the stability of an open living system and the equilibrium of a closed inorganic system. In the latter, according to the second thermodynamic law, the internal disorder does not decrease (but nor increases, this reached internal equilibrium not generating any momentum), and without external determining conditions, the system last. In the open living system, the internal necessary disorder is fluctuating according to the exchange relations and their results in the system; and when, with all the exchange relations, the beneficial disorder decreases and is substituted with equilibrium, the life disappears).

Since just the openness of the system allows its self-regulation, stability and activity, then this cardinal feature is justly considered as emphasising two characteristics of GST. One is that GST opposes to the then in fashion *organisation theory* (OT), because if the latter considers only the *system* (that has to be better organised), GST considers the system of systems (*the system and its environment*). The other is that GST promotes *holism* – as scientific perspective and practical care – but OT occurs only within the mechanist pattern, focusing exclusively on the system[21]. In GST we have systems in systems, or layers of reality, "the unifying principle" being only "that we find organisation at all levels"[22].

The second main problem is that of the *epistemological principles* – having correspondence in the real world – which are basic, indispensable in the treatment of systems. These principles are: 1) the *structural/constitutive interdependencies* of systems, thus of systems and their environment; 2) the *equifinality*: meaning that for a closed system, the final state is determined exclusively by its initial conditions, while for an open system the final state is reached from different initial conditions and in different ways; 3) the *feedback*, not meaning here physical and chemical reactions, but only those of the living and anthropogenic systems; in the latter, the processes of decision and control are conscious; 4) the *multiple causality*, related not so much to the non-mechanical view about element-system relations, than to the *functionality* of system in the environment; in this type of relations, there is the difference between functionality based on *stimulus-answer* pattern, specific to the living systems, and the *holistic* functionality, specific to the anthropogenic systems.

Anyway, the anthropogenic principles are: 5) *creativeness* of elements, i.e. human individuals, and 6) the complex *sociality* of the individual and collective creation.

Ludwig von Bertalanffy's warning

Actually, *General System Theory* was preceded by *Robots, Men and Minds: Psychology in the Modern World*[23]. In this book, the motif was that of

- the modern mechanistic view about man, reduced by the mechanistic science, and including by psychology, to a *robot*, a mechanism based on *stimulus-response* scheme, i.e. "the doctrine of the primary reactivity of the psycho-physiological organism", on "the equilibrium theory of behaviour" (where the natural state of the organism would be that of rest), and on "the utilitarian principle" (to reach the prescribed goal with minimum expense)[24], and

[20] Ludwig von Bertalanffy, *General System Theory: Foundations, Development, Applications*, New York, George Braziller, 1968, p. 191: "life is not maintenance or restoration of equilibrium, but of disequilibria".
[21] See as an example of mechanistic view, that implicated in the shale gas exploitation, Ana Bazac, "A page in the history of present technology : a strange attitude of some scholars towards some harmful civil technologies", *Biocosmology – Neo-Aristotelism*, Vol. 4, No. 3, Summer 2014, pp. 240-253.
[22] Ludwig von Bertalanffy, *General System Theory*, p. 49.
[23] Ludwig von Bertalanffy, *Robots, Men and Minds: Psychology in the Modern World*, New York, George Braziller, 1967.
[24] Ibidem, pp. 7, 9.

- of the necessity to transform science into an "open system", able to criticise itself and to outstrip the mechanistic pattern that overhangs even the newest form of OT, cybernetics.

Therefore, in *General System Theory* all these aspects were included and developed from the standpoint of epistemology of science.

The model of man as robot, still dominant[25], a model of a programmable, searching for equilibrium and diminution of effort being, is denied by the contemporary history: it not only illustrates reductionism, but it is noxious; in the present consumer society, has von Bertalanffy insisted, there is more mental disturbance that in the WWII, except the combatants. Why? Because: the programming of spontaneity and creation, and the reduction of the creative effort are the sign of and lead to the *lack of sense of life*.

But the robot man model shows that *the social logic cannot be reduced to biology, as biology itself cannot be reduced to physics and chemistry*[26]. Nevertheless, if this reduction takes place, if the scientific model of man is man as a robot, it is because – and just the holist principle explains this – the scientific-technical progress may well coexist with the social decay (and disruption of symbolic functions which are, indeed, specific to man).

The *principium individuationis* – "the ultimate precept: man as the Individual"[27] – as the only that shows the progress from the inorganic to the living and to the anthropogenic – requires not only the material well-being of the individual, but also its psychical self-realisation, as Maslow, a psychologist "committed to the organismic theory of personality"[28], has demonstrated; but, I dare add, this aspect emphasises just that the individual needs and produces trans-individual values, for example, social ideals.

In this way, the epistemology of the construction of concepts consists in the insistence on the *responsibility* of scientists just in this frame.

Instead of conclusion: what we have to retain from von Bertalanffy's warning

In a *feedback* we have to consider *both* directions of the relation. Thus, the direction on which one insists, officially, is that science and technology strongly influence society. But just society is the determinant framework of science and technology. This direction is unnoticed, because in fact not "society", but the *power/decision system* is this framework. The interests and values which determine the science policy belong to the owners of power. In fact, all the social values are translated through the dominant interests and values.

People have had a systemic approach before the system theory. They have pursued the maximisation of the target output the more economically possible and without considering the residual output. But really, the most difficult – and the main – goal was the understanding of the system (S): the epistemological problem, subordinating everything else, was the solving of the S problems; a solving targeted and circumscribed, separated from the environment. In this epistemology, holism was not necessary.

But from the 50s of the last century, the scientists have *demonstrated* the necessity and possibility of holistic approach. Ecology, the economisation of particular output systems (for

[25] Ludwig von Bertalanffy, *Robots, Men and Minds*, p. 12: "The image of man as a robot is a projection into science of the *Zeitgeist* of the period, as, in the last resort, all basic theoretical notions are…behaviour as a business transaction with minimum expense and maximum gain – this is a perfect expression of the philosophy of the commercial society…".

[26] See in present the use and abuse of reductionism in biology – especially in molecular biology – and its critique: Fulvio Mazzocchi, "The limits of reductionism in biology: what alternatives?", *E-Logos (Electronic Journal for Philosophy)*, University of Prague, 11, 2011, pp. 1-20.

[27] Ludwig von Bertalanffy, *General System Theory*, p. 52.

[28] Idem, p.105.

example, the use of tailings or collateral output as new raw material), energy science (where Nicolas Georgescu-Roegen has *demonstrated* the imperious demand of energy saving to stop any activity related to wars) were only some domains which pointed out the new general system theory/holism.

Nevertheless, the present world is suffocated by *all types* of garbage (presenting landscapes as "ghosts" of the violence they were treated in the pattern of modernity[29]). And science and technology did not keep up neither with the necessity of holistic approach and nor with the priority of negative outputs solving[30]. The researchers "discover" nowadays the necessity (and profitability) of waste management and the reuse of waste, since the "global depletion of natural resources leads to a global competition for resources"[31]. And only in the last decades have some states and the EU officials insisted on the necessity of waste management: but the private companies have found ways to sidestep the eventual fines, since the present invitation of the EU Commission to reduce waste[32] was accompanied by the companies policies' externalisation of waste[33] in two ways (delocalising the polluting and harmful production in other countries – thus releasing toxic waste in the nature of these countries – and exporting waste), and only with the refusal of some countries to accept the European waste[34] has the EU initiated new laws[35].

Concerning waste as secondary output, the scientific research has *demonstrated* that the economic development of Western countries took place not only on the robbery of resources of non-Western countries, but also on their pollution and destruction[36]. Even the world economic integration[37] takes place today through the above-mentioned processes.

Then – but in fact, firstly – the abundant and increasing waste (with all the programmes of recycling and resource saving) in the present world is due to the *capitalist* industrialisation and model of life. Since the profit is realised only by selling more and more products, for this reason being necessary the induction of false needs, the consume grows not necessarily showing the

[29] See Anna Lowenhaupt Tsing, Nils Bubandt, Elaine Gan, Heather Anne Swanson (Eds.), *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene*, Minneapolis, London, University of Minnesota Press, 2017.

[30] See the huge pollution made by the use of nuclear energy and, here, especially by the nuclear waste (Robin Delobel, *Les dettes que nous laisse le nucléaire*, 17 novembre 2017, https://www.mondialisation.ca/les-dettes-que-nous-laisse-le-nucleaire/5618864).

[31] Martin Oteng-Ababio, "Rethinking waste as a resource: insights from a low-income community in Accra, Ghana", *City, Territory and Architecture. An interdisciplinary debate on project perspectives*, 1, 10, 2014, https://doi.org/10.1186/2195-2701-1-10.

[32] *Questions and answers on the Commission Communication "Towards a Circular Economy" and the Waste Targets Review*, Brussels, 2 July 2014, http://europa.eu/rapid/press-release_MEMO-14-450_en.htm.

[33] See only C. Gibbs, M.L. Gore, E. F., McGarrell, & L. Rivers, "Introducing conservation criminology: Towards interdisciplinary scholarship on environmental crimes and risks, *British Journal of Criminology*, *50*, 2010, pp. 124–144; Lieselot Bisschop, "Is it all going to waste? Illegal transports of e-waste in a European trade hub". *Crime, Law and Social Change*, *58*(3), 2012, pp. 221–249. But there are many articles about the externalisation of developed countries' waste in Latin America and Asia.

[34] See China in 2018 and 2018: Ivana Kottasová, *China trash ban is a global recycling wake up call*, April 20, 2018, http://money.cnn.com/2018/04/20/news/china-trash-recycling-environment/index.html: "China's trash import ban is giving the global recycling industry an enormous headache. The flip side: the world has finally been forced to rethink its approach to waste".

[35] *Waste no more: Introducing Europe's new waste laws*, 2018, http://eeb.org/waste-no-more-introducing-europes-new-waste-laws/.

[36] See only Renaud Duterme et Eric de Ruest, *La dette cachée de l'économie, le scandale planétaire*, Bruxelles, Éditions Les Liens qui Libèrent, 2014.

[37] See only Jean-Baptiste Malet, *L'Empire de l'or rouge: Enquête mondiale sur la tomate d'industrie*, Paris, Fayard, 2017.

But also, though in an oblique way, Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton, Princeton University Press, 2015.

increase of living standard, but the "conspicuous consumption" emphasised by Thorstein Veblen in his *Theory of the Leisure Class: An Economic Study in the Evolution of Institutions*, 1899. The consequences of this consumption were described by Vance Packard[38] as "progress through throwaway spirit", "progress through planned obsolescence", "commercialisation of life" and "vanishing resources". Indeed, in this type of society, "cheerful robots"[39] are necessary: to ceaselessly buy and enjoy this. And in this type of society the *excessive*, the *superfluity*, the *too much* thrive, generating even more excessive waste because of the "out of fashion" character of new and new acquisitions.

The image of "Debrisphera"[40] – where the municipal waste generated mainly by households is only 10% from the waste produced by the EU in a year, and the EU waste management programmes concern mostly these 10%, but not at all the waste produced by war industries, war exercises and war, and rather shyly the waste produced by companies – should once more redefine the concept of waste as secondary output. Could we characterise waste as unintentional output? Neither its treatment during the process of economic growth and nor from the standpoint of its prevention and recycling do enable us to define it as unintentional, since it depends on *capitalist programmes* of both increase of production for profit and of waste management.

The agglomeration of waste and the unstopped production for profit directly contribute to the critical unbalances of the environment and to the *accelerated transformation* of the whole nature towards more critical points, even thresholds[41].

Finally, the analysis in terms of output and, especially, of secondary/residual one, allows a more scientific (economical and humanist at the same time) representation of inputs and, keep attention, of systems as well. The Jevons paradox[42] – that *demonstrates* that even if the technological progress allows the increase of efficiency of resources use, this fact generates an increase of the resources use – shows that *at the two ends* of the process of production, the *carrying capacity*[43] of the environment is exceeded (under the above-mentioned *social* conditions). But, obviously, this situation requires and presses for transformations not only at the level of input technologies efficiency and neither only at the level of waste management and prevention, but just at the level of the production system. Once more, the general system theory proves its reason to

[38] Vance Packard, *The Waste Makers*, New York, David Mckay Company, 1960.

[39] C. Wright Mills, *The Sociological Imagination*, New York, Oxford University Press, 1959, spoke about the "cheerful robot", pp. 168, 169, 170, 171 and 175. Von Bertalanffy did not quote him.

[40] Term created by artists Anca Benera and Arnold Estefán presenting the project *Debrisphera* in Viena, at Museum Moderner Kunst, in October 2017. But the debris do not recall only the discussed waste, but especially "Landscape as an extension of the military imagination", https://www.beneraestefan.ro/works/debrisphere/.

[41] Will Steffen, Wendy Broadgate, Lisa Deutch, Owen Gaffney and Cornelia Ludwig, "The trajectory of Anthropocene: The Great Acceleration", *The Anthropocene Review*, 2015, pp. 1-18: the rate and magnitude of the human alteration of the environment has changed from the mid-20th century on. And since the processes leading to this alteration still continue, this Great Acceleration (that certainly is the result of former cumulative tendencies) has no basis to stop. On the contrary: Robert Hunziker, *The Extinction Event Gains Momentum*, 01/05/2018, http://www.defenddemocracy.press/the-extinction-event-gains-momentum-2/

And: Sanae Chiba, Hideaki Saito, Ruth Fletcher, Takayuki Yogi, Makino Kayo,Shin Miyagi, Moritaka Ogido, Katsunori Fujikuda, *Human footprint in the abyss: 30 year records of deep-see plastic debris*, *Marine Policy*, Japan, 2018, pp. 1-9.

[42] See John M. Polimeni, Kozo Mayumi, Mario Gianpietro and Blake Alcott, *The Jevons Paradox and the Myth of Resource Efficiency Improvements*, London, Earthcan, 2008. Kozo Mayumi is a student and follower of Nicolas Georgescu-Roegen and has considered him as a main intellectual resource for this book.

[43] See William Robert Catton, Jr., *Overshoot: The Ecological Basis of Revolutionary Change*, Urbana, University of Illinois Press, 1980, who has coined just this term.

be[44], and also the social critique of "neutral" approaches of technology, science, efficiency, and progress[45].

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[44] Debora Hammond, "Philosophical and Ethical Foundations of Systems Thinking", *Triple C (Cognition, Communication, Co-operation)*, 3, 2, 2005, pp. 20-27.

[45] See Jason W. Moore (ed.), *Anthropocene or Capitalocene? Nature, History and the Crisis of Capitalism*, Oakland, Ca., PM Press, 2016.

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