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# Human Approaches to the Universe

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# Informational Universe
# A Praxeo-Onto-Epistemological Approach

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The spread of information and communication technologies in the course of the development of societies can be said to have triggered an "informational turn" in science and humanities. The concept of information and related concepts are widely used on both science and humanities. Thus the informational turn sets the stage for overcoming the divide between the two cultures and restituting metaphysical concepts brought forth in Antiquity, in particular, by Aristotle, albeit on a higher level. The universe can be conceived of as something that is self-organising. Introducing self-organisation is giving a new answer to the problem of how to relate inert matter on the one hand and living matter and mind on the other. This article will reveal epistemological, ontological and praxeological implications of this view of the informational universe.

## *1. Ways of Thinking in Cosmologies*

Human approaches to the universe may be distinguished according to the ways of thinking they reveal. Speaking in abstract terms, ways of thinking concern the consideration of how to relate identity and difference.

There are, in terms of ideal types, several ways conceivable:

- either the different sides are considered identical, that is, either side of the difference may be regarded as the base of identity; hence one way of thinking establishes identity by eliminating the difference at the cost of the differentiated side, it reduces the differentiated side to the undifferentiated one what is known as reductionism; another way of thinking establishes identi-

ty by eliminating the difference at the cost of the undifferentiated side, it takes the differentiated side as its point of departure and projects (extrapolates) from there to the undifferentiated one and may be called projectionism;
- or the different sides are considered different, that is, all relationships between them are abandoned; this way of thinking establishes the difference by eliminating identity; it dissociates both sides of the difference and treats them as disjunctive; this is what dualism (pluralism) is about;
- or they are considered to be both identical and different so as to establish identity in line with the difference; this way of thinking integrates both sides of the difference and differentiates the identical at the same time; it is a way of thinking that is based upon integration and differentiation and may be termed dialectic as it mediates opposites.

In the case of approaching the universe from a human perspective ways of thinking gain a more concrete meaning: the universe plays the role of that which is identical and the human and the nonhuman play the role of the two sides of the difference; the question that arises is how they make up the universe. This goes hand in hand with the question of how humanities and social science, on the one hand, may or may not be linked to the so-called exact science, on the other, and may or may not contribute to the unity of science.[1]

Reductionist approaches reduce the human side of the difference to the nonhuman side and set up the unity of the universe as a natural one. Hence their name: naturalism.

Projectionistic approaches use the human side as their starting point and project properties of the human side onto the nonhuman one, thereby unifying the universe on the basis of anthropomorphisms. These approaches are anthropomorphistic.

Dualistic approaches dissociate the human and the nonhuman side and let the universe fall apart. The anthropic and the natural form distinct worlds due to the so-called two-cultures-thinking.

Dialectical approaches integrate the human with the nonhuman side while they differentiate the totality of the universe. The anthropic and the natural are entangled, interwoven, permeated in a complicated way that is described by dialectics.

Though naturalistic approaches suffer from the underlying naturalistic

[1] HOFKIRCHNER 1999.

fallacy – that pretends to deduce explananda describing human phenomena from premises describing natural laws –, they yet form the materialistic mainstream of today's cosmology. Weak and strong formulations of the so-called anthropic principle which, in turn, are trapped in the anthropomorphistic fallacy – that postulates as explanans for natural phenomena premises that include concepts that apply to the human sphere – form the idealistic counterpart of materialistic cosmology. Another idealism that would restrict natural laws to nature and human regularities to humans would not qualify for being regarded as cosmology.

The argument we want to bring forth is that the paradigm shift from the so-called classical, mechanical, Newtonian view of the world to the world view of the sciences of complexity, of theories of dynamic, open, nonlinear, adaptive and evolutionary systems – a secular change that has been underway since the sixties of the last century and has been penetrating discipline by discipline – seems to undermine reductionistic or projectionistic approaches that by way of short cuts transfer concepts from nature to humans or from humans to nature as well as views that claim an unbridgeable divide. This shift rather seems to underpin a cosmological view that mediates between nature and humans by undertaking generalisations which start from the particular at either side and are directed towards the universal comprising both nature and humans and by producing reverse trains of thought that arrive at the specialised as well. This is so because findings in the field of complex systems and concepts of self-organisation do support a dialectical way of thinking. We want to show how these findings and concepts are ready for being generalised in that way.

## *2. The View of the Self-Organizing World*

We live in an age of global problems that concern the survival of humanity. As it is in the nature of these challenges to be complex, they have to be approached in a similarly complex fashion. A paradigm shift as far-reaching as never seen before is under way. What is known as sciences of complexity, self-organisation theories, evolutionary systems theories, is an element, if not the core, of this overall shift.

According to this thinking, all science serves to support efforts to master the global challenges. According to it, more and more researchers discover evolutionary systems no matter which real-world object they may be in-

vestigating, for the provision of specialised knowledge about the functioning of different self-organising systems is essential to influence them in such a way as to trigger the most promising development paths. Finally, according to it, diverse methodological approaches are less and less viewed as impediments that endanger the unity of science; rather, they are increasingly regarded as useful means towards the same end and as an enrichment of science as long as the common basis of the different methods is not violated.

Before we present results of the sciences of complexity and make an attempt of generalisation we want to introduce the categories along which we will classify them. These categories stem from philosophy.

## 2.1 Praxeological, ontological and epistemological assumptions revisited

Philosophy is the most general reflection of humans and their position in the world. There are, at least, three fundamental questions that have been constituting philosophy since ever, though they have been put in different ways. One question is about values, norms, imperatives, guidelines for acting. Another question is about the world as it is, its properties, be it with or without us. A third question is about our ability to produce knowledge. The first question makes up the domain of ethics, aesthetics and axiology, the second makes up the domain of ontology, and the third the domain of epistemology including the methodology of inquiry.

These three domains may be tackled either as separate fields of philosophy, or as networked and even nested. Historically speaking, awareness of interdependencies of the fields has been growing.

After times of prevailing realistic stances in ontology, varieties of radical constructivism arising in the second half of the last century have put emphasis on the interdependence of epistemological and ontological questions (though some of them tended to end up in mere solipsism). According to them the world as it is is difficult to approach since our assumptions of how the world is turn out to rely on specific methods of human cognition. A moderate stance trying to reconcile realism with constructivism is onto-epistemology as coined by Hans Jörg Sandkühler[2] and shaped by Rainer Zimmermann.[3] We tie up to this strand and want to complement the interrela-

[2] SANDKÜHLER 1990, 1991, 34-37, 353-369.

[3] E.g. ZIMMERMANN 2002, 147-167.

tionship of ontology and epistemology by the relation to ethics, aesthetics and axiology all of which we propose to include in so-called praxeology.

Praxeology is meant as the philosophical theory of praxis. Praxis refers to society and its human actors. It can be defined as the process of co-action (of human co-actors) upon reality which, in turn, can be defined as the field of interaction (of human actors with the environment) that is mediated by method which, in turn, can be defined as the way of action (of those human actors). In terms of subjects and objects, praxis is the totality of the human subject-object-dialectic, reality is what is, so to say, objecting to becoming subject to humans, and method is the subjective way of making objects subject to humans. It becomes clear from that order of definitions that praxis builds upon reality and that reality builds upon method, be it material or ideational. Hence, if ontology is meant as the philosophical theory of reality and epistemology as the philosophical theory of the method of inquiry, praxeology is based upon ontology and ontology on epistemology. This relationship of encapsulation of domains of philosophical disciplines, and of the philosophical disciplines themselves, does not model a one-way process of causal influence or linear inferences. Both bottom-up as well as top-down processes have to be recognised. There is relative autonomy of each of the domains (praxis may shape reality but reality gives the scope of possible practices, reality may shape method but method gives the scope of possible realities) and of each of the disciplines (praxeology does not fully determine ontology and ontology does not fully determine epistemology, and vice versa).

The rationale for defining subject matters and respective theories in such a concatenated way is that we try to give an appropriate sketch of the following relations: certain interests (that reflect certain practices) define the sphere of intervention (that is made up of objects in which subjects are interested and is characterised by a boundary beyond which there are no real objects as long as there is no subject interested in them) and certain spheres of intervention (that reflect certain realities) define the scope of instruments (that is made up of means which are useful for intervention and is characterised by a boundary beyond which there are no real means as long as they do not fit the object); and, in turn, certain instruments (that reflect certain methods) can help construct a certain sphere of intervention only by which different realities are excluded and certain spheres of intervention can meet a certain bunch of interests only by which different interests are excluded.

Thus, taking explicitly a human stance, we can reformulate the fundamental questions of philosophy by starting with the praxeological question and subsequently introducing the ontological question and the epistemological question, each one being the presupposition for the question before:

1. How should the world be like?
2. How can humans make the world how it should be like?
3. How can humans understand how they can make the world how it should be like?

Having guidelines for action presupposes having ideas about where human actors start from and having ideas about where human actors start from presupposes having tools to recognise the starting point. If humans want to succeed in changing the world they need to know about the relations that allow to achieve the goals they have set. And in order to gain this knowledge they are obliged to apply all means that seem worthwhile. So our praxeo-onto-epistemological standpoint is indeed one in which praxeology does matter: ontic propositions bear the stamp of practical instructions and pass this stamp over to epistemic methods.

It becomes clear that by defining praxis as the subject matter of praxeology we denote by this term the philosophical theory of human actions in regard not only to their efficiency, effectiveness and efficacy but moral value and beauty as well.[4]

Our way of encapsulating praxeology, ontology and epistemology may be regarded as generalisation of what action theory is pointing at when establishing a relationship between ends, ways and means. Ends refer to practical interests, ways refer to ontic interventions, and means refer to epistemic instruments.

Furthermore, the way we conceive of the nestedness of praxeology, ontology, and epistemology resembles the way semiotics may be structured. Semiotics is about signs and may be divided into pragmatics, semantics and syntactics as subdisciplines. According to the perspective advocated here semantics is a subset of pragmatics and syntactics is a subset of semantics. Pragmatics deals with the use of signs, semantics is about the signs' relation to their referents and syntactics talks about signs in themselves and how their components fit together. If a sign is something that is produced and/or used by someone with the purpose to refer to something else in or-

[4] See different views in MISES 1999, KOTARBINSKI 1965, BUNGE 1999, COLLEN 2003.

der to express the meaning of it to someone else, then it makes sense to consider the pragmatic aspect as uppermost level, the semantic aspect as intermediate level and the syntactic aspect as the bottom level since the usage defines the reference and the reference defines the production of signs while the production gives rise to a certain scope of possible references which, in turn, gives rise to a certain scope of possible usages. If we look upon sign production as method, if we look upon the sign referents as reality and if we look upon the sign use as praxis, this analogy between praxeology-ontology-epistemology and pragmatics-semantics-syntactics seems not casual.

There may also be historical evidence for the subsequent differentiation of the philosophical disciplines of praxeology, ontology and epistemology. A first stage of development may be the existence of mythology which in ancient societies was a reflex of human praxis as an undifferentiated whole. Another stage of development may be characterised by the advent of the philosophy of nature produced in greek civilisation and contemplating the object of practices. A third stage of development, at last, may be introduced by specialised philosophy of science considerations which initiated the self-reflection of human inquiry.

## 2.2. Universals of the sciences of complexity

Praxeology, ontology and epistemology form the categories along which we can try to classify the results of the sciences of complexity. In our terms, sciences of complexity have one central focus: self-organisation. Self-organisation is the most distinctive character of systems that have the capacity to contribute to evolution: it is the process and result of the spontaneous build-up of order. To recognise the self-organising capability of matter, of nature, of real-world systems has implications for praxeology, ontology and epistemology.[5]

[5] See HOFKIRCHNER 2004.

### 2.2.1. Praxeological results and generalisations: Evolutionary Systems Design Principles and Deliberate Activism

In a systems theory perspective, dealing with complexity is located inbetween two poles – the pole of algorithmisation and the pole of nonprogrammability. Algorithmisation means the process of developing clear-cut and unambiguous instructions that can be carried out by the help of computers as universal machines. Up to now the bulk of technologies has been designed according to such a rule, but disasters increasingly render this view inappropriate. Nonprogrammability refers to just this experience that systems in nature do not obey that rule and escape simulation and intervention and cannot be reproduced.

Evolutionary systems design principles which can be abstracted from the wide range of findings in system research avoid to get deadlocked at one of the poles. They encourage to make use of the systems' dynamic and stress the point that knowing about nonlinearity and sensitivity may help to choose those inputs that trigger developments in the overall self-organisation process of the system that are favourable to those who make the inputs. System processes may be facilitated or may be dampened. Also it is important to influence the general set-up of the system only and abandon instructions down to every detail so that relative autonomy is granted to the subsystems. All in all, this kind of systemic "intervention" can be labeled "decentralised context steering".[6]

In a philosophical perspective, decentralised context steering finds its general pendant in a kind of piecemeal engineering Karl Raimund Popper[7] introduced to the terminology of social sciences or in an attitude Francis Bacon[8] advocated in his saying that changing the world requires observing its laws, if we – today – include the law of unintended consequences.[9]

This kind of activism is not a practicism that guides action according to the maxim that all that is feasible shall be realised thereby assuming that it is desired too. Nor is this kind of activism a utopian or romantic wishful thinking that holds that what is desired is feasible too. Both practicism and wishful thinking believe in total controllability and result in expensive brute-force

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[6] JESSOP 1997, TEUBNER and WILLKE 1980, WILLKE 1995.

[7] POPPER 1962.

[8] BACON 1990.

[9] MERTON 1936, 1957.

interventions. Nor is this kind of activism an inactivism that believes in total uncontrollability, condemns any kind of intervention and fails to reconcile the feasible and the wishful. It is deliberate activism that takes responsibility for producing the unity of the feasible and the wishful. And it does so by working out the ascendence from the here-and-now to the not-yet in the sense of Ernst Bloch[10] and the ascendence from the less good to the better.

### 2.2.2. Ontological results and generalisations: Evolutionary Systems Stage Model Principles and Less-than-strict-Determinism

Mechanism and spontaneity are the two extremes taking complexity as basis can be trapped in. Mechanism refers to one-way cause-effect-relationships underlying the systems' processes and structures while spontaneity denies this and ascribes irreversibility to the processes and irreducibility to the structures. The computer metaphor insinuates the whole world is working like a computer while, on the other hand, only less-than-middle-range narratives are said to be the best to be achieved.

The stage model of evolutionary systems, however, is based upon the principle of emergentism and the principle of asymmetrism. Emergence takes place in metasystem transitions in which by the interaction of proto-elements systems are produced[11], evolution is characterised by punctuated equilibria.[12] Asymmetry describes the architecture in which higher levels are based upon lower ones but nevertheless exert a downward causation in turn, supersystem hierarchies encapsulate subsystems in the way Arthur Koestler talked about holons.[13]

If we try to generalise these system theoretical findings and raise them onto a philosophical level, we are confronted with the determinism-indeterminism divide. There is no determinacy without indeterminacy and no indeterminacy without determinacy. The French philosopher Edgar Morin aptly coined the term "chaosmos" to indicate that the world is cosmos and chaos at the same time.[14] When Popper talked about propensities in one of his last publications, he had in mind the very same idea of a universe that

[10] BLOCH 1985.

[11] JOSLYN, HEYLIGHEN, TURCHIN 1997.

[12] ELDREDGE and GOULD 1972, GOULD and ELDREDGE 1977.

[13] KOESTLER 1972.

[14] MORIN 1992, 53–64.

is inclined to exhibit some properties[15] rather than governed by strict natural laws. The American pragmatist Charles Sanders Peirce said that evolution takes habits.[16] One of us called this idea of weak determination elsewhere less-than-strict-determinism.[17]

Less-than-strict-determinism is not a preformationism according to which evolution is only unfolding of something already existing and not a merism according to which wholes can be reduced to their parts. Both preformationism and merism reduce chance to necessity. Less-than-strict-determinism is not teleologism or holism which project chance in the form of a not existing goal or a contingent whole onto necessity. And it is not a dichotomism of necessity and chance. It tries to work out the unity of necessity and chance by the ascendence from the old to the new and from the parts to the whole.

### 2.2.3. Epistemological results and generalisations: Evolutionary Systems Methodology Principles and Reflexive Rationalism

Methods of thinking in complexity are exposed to the tension between formalisation and the nonformal. Formalisation is the activity of symbolising a real-world process in order to be able to operate on the symbols while taking into consideration rules of combination of the symbols only and neglecting their referents. Having carried out the operation you can refer to the referent again. Formal logic and mathematics are instances of such languages. They can work if and because the real-world referents are in reality linked in the strict deterministic way formal logic and mathematics link symbols. Systems modelling always confronts with situations that are not that way formalisable and hence unpredictable. Computer science knows about the problem of the nonformal.[18] Hence the call for qualitative methods as opposed to quantitative ones. Qualitative methods are said to be the only appropriate for the nonformalisable.

Emergence in phases of evolution, including the appearance of novel qualities in developments, and differences between system levels cannot be

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[15] POPPER 1997.

[16] PEIRCE 2000.

[17] HOFKIRCHNER 2001.

[18] See FUCHS-KITTOWSKI 1992.

formalised in a way that there is a transformation that leads unequivocally from one to another. Evolutionary systems methodology therefore has to recognise the principles of formalisation gaps: in the case of phase transitions where a leap in quality exists between the state of the system at one point of time (t) and the following state (at time t+1) and in the case of level shifts where a leap in quality exists between one layer of the system and the adjacent layer up or down (micro- and macrolevel). It holds it is impossible to find an operation in the mind that accomplishes the leap from one quality to another in an unambiguous and compelling way.

However, in a general philosophical perspective, there is a terminology that allows to mediate different qualities. With the help of this terminology the one can be described as the condition for the other and the other, then, can be described as the conditioned. This is the way out of the deductivism-irrationalism chasm. Deductivism favours complete deducibility while irrationalism is willing to accept any nondeducible statement. Within deductivism you may distinguish analytical thinking with a naturalist bias and synthetical thinking with an anthropomorphistic bias. The first reduces the historical to the logical (saying laws in nature are nothing but intelligible necessities), the second projects the historical onto the logical (saying laws are nothing but contingent). Irrationalism underlines the opposition of the logical and the historical.

What we would like to term reflexive rationalism abstains from providing causal explanations and predictions which are conclusions drawn from premises as deductive rationalism would do and it refrains from disseminating narratives that deny inferences as irrationalism would do. Reflexive rationalism establishes the unity of the logical and the historical by announcing the principle of the search for the approximate necessary, but not in all cases sufficient, condition. The approximate necessary condition is the representation of the real prerequisite for the quality to become, be it in phases or in levels. The ascendence from the potential to the actual as well as from the abstract to the concrete is carried out by jumps from the condition to the conditioned.

## *3. The Rise of the Informational Universe*

The philosophical generalisations of the results of the sciences of complexity are useful to approach an answer to the question of which place infor-

mation has in the universe and which role creativity plays.[19]

There is evidence for the fact that the universe humans inhabit has been undergoing a process of evolution at least since 13.7 billion years. Given the insights of the philosophical underpinning of self-organisation theory, it is hard to fancy a beginning like the Big Bang. For "nothing will come of nothing". As far as we know, each stage in any evolutionary process is prepared by a preceding stage in that the preceding one builds the foundation for the next irrespective of what the next stage will be like. Hence the stage before the first stage human science acquires knowledge of is not "nothing" but "something else" – an object of human imagination and inquiry. This is an argument for the eternity of the overall evolution put forward by prominent materialist thinkers as Friedrich Engels.[20]

Evolution apparently reaches ever-higher complexity which, however, is recovered by ever-new simplicities. The points of bifurcation that are passed from stage to stage may be deciphered as symmetry breaks. So self-organisation theory serves well in interpreting the how of the evolution of the universe.[21]

## 3.1. Information and self-organisation

Information seems to be as fundamental a building block of the universe as matter and energy is. So far, however, there is no common agreed-upon concept of information.[22] There are objectivistic approaches, originating from the so-called "hard" sciences, that consider information a substance because of its ability to be received and processed in cognitive contexts, to be transmitted in communicative contexts, and to be stored and retrieved and distributed in co-operative contexts. On the other hand, there are subjectivistic approaches, originating from the so-called "soft" sciences, that believe information to be a mental construct produced by human actors internally, or interactively, or externally according to the context.

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[19] Esoteric answers range from an early book of YOUNG 1974 to a recent book of GÖRNITZ and GÖRNITZ 2002.

[20] WOODS and GRANT 2002, 177-222, see FUCHS 2003.

[21] See e.g. EBELING and FEISTEL 1994, KANITSCHEIDER 2002, 467-474, SMOLIN 1997, SMOLIN 2003, 201-205, LAYZER 1990.

[22] See CAPURRO and HJØRLAND 2003.

An integrative information concept cannot be satisfactorily formed on the basis of such one-sided views. What we call the Unified Theory of Information perspective has to consider both the objective and subjective aspects of information which have to be related to each other in a proper way. The objectivist outlook is right in stating that information is a phenomenon out there (an object) and not merely a human imagination. The subjectivist outlook is right insofar it states that information occurs only if there is a freedom of choice for the thing to which generating and disposing of information is attributed (a subject). However, regarding the objectivist outlook, we have to limit the scope of objects with which information is said to be found to those objects only that take the role of subjects, and regarding the subjectivist outlook, we have to enlarge the sphere of subjects from that of humans only and include non-human ones, too.

According to this unifying perspective, information is a relation of self-organising systems to their environment (cognitive context), to their co-systems (communicative context), or to the supersystem they give rise to (co-operative context). In terms of evolutionary systems theory, information is generated iff self-organising systems relate some external perturbation to the spontaneous build-up of order they execute when exposed to this perturbation. To translate into terms of triadic semiotics, by doing so, the self-organising systems assign a signification to the order and make it a sign which stands for the so signified perturbation. Thus the process of self-organisation coincides with the process of information-generation (sign-production) and so do their respective results. The concepts of self-organisation and information turn out to be co-extensive.

## 3.2. The rise of subjectivity

Speaking of subjectivity means returning to the terms subject and object. According to our praxeo-onto-epistemological point of view, the difference between subject and object may be seen in that a subject is capable of determining itself while an object is not. An object is something that is determined by something that is not itself. Being a subject supersedes being merely an object. While an object has no possibility of acting in ways different from merely reacting to external determinants, a subject is capable of responding in its own, unequivocal way, that is, it can make use of degrees

of freedom, of freedom of choice, of choice between options all of which it disposes of and thus makes the internal determine. It may object to external determinants while objects do not.

So, if an object is something that is subject to mere determination by something else and if a subject is something that objects to mere determination by something else, then information-generating, self-organising systems display a certain subjectivity, for the generation of information is tantamount with drawing a self-made distinction by the irreproducible, irreversible, irreducible, unpredictable build-up of order during the process of self-organisation.

The minimal unit of subjectivity is a something that is provided with a minimal quantum of degrees of freedom to act. This something is the most rudimentary and most primitive subject.

The making of something subject to oneself which makes oneself a subject undergoes a process of unfolding so as to let us distinguish between different types of subjects according to the degree of subjectivity they manifest. It is different types of systems that show different degrees of subjectivity. The more complex a system, the more subjectivity it displays. This holds for the ascendence from physico-chemical self-organising (dissipative) through biotic (autopoietic) to social (re-creative) systems and for the progress of society as well. In the course of evolution, there is a drift from drivenness towards end-directedness and from materiality towards formative power.

Aristotle knew four types of causes: the effective (causa efficiens), the final (causa finalis), the material (causa materialis) and the formal (causa formalis) one. In a strive for scientificity that avoided resorting to the supernatural, post-medieval science abandoned the latter three of them. However, in the perspective of evolution and systems it is worth reconsidering all four types of causes without need to resort to the supernatural. You can arrange them on two axes. One axis shows the diachronic dimension of systemic evolution and goes from drivenness to end-directedness, another shows the synchronic dimension of evolutionary systems and goes from materiality to formative power.[23] You can arrange the effective and final cause on the first axis and the material and formal cause on the second one.

[23] BRUNNER and KLAUNINGER 2003.

Effective cause connotates a driving force in the process while final cause connotates rather to pull than to push. But finality does mean influence "from the future" as little as effectivity means exerting pressure "from the past". Each process paves the way for the future by its own history. It brings into existence a certain range of possibilities and a complementary range of impossibilities. Those possibilities do exist in the present and one of them will be selected and realised and then open up another range of possibilities. Compared to the range of impossibilities, the process converges to one end after the other through a series of concatenated ranges of possibilities.

And material cause connotates the substantial base in the structure while formal cause connotates the shaping of it. And formality does mean influence "by consciousness" as little as materiality means exerting pressure "by matter". Each structure bears the stamp of how its constituents compose it. The constituents produce what they constitute by producing constraints as well as enablers which represent the form.

The evolutionary systems stage model assumes that it is already the most primitive type of self-organisation that not only exhibits effective and material causation but also to some extent final and formal causation. Dissipation realises some end (as to the energy throughput) as well as some form (by which the energy throughput is served) though not consciously. Dissipative systems may hence be termed "teleomatic"[24] with regard to the primitive type of end-directedness they exhibit (they automatically seem to realise an end) and "self-referential" with regard to the primitive type of formative power they exhibit (they refer to themselves in that there is a feedback established from the macro- to the microlevel). Autopoiesis goes beyond mere dissipation. It does not only realise some end but inheres it, the end is implicit (survival for any living system). Hence autopoietic systems may be termed "teleonomic". Autopoiesis furthermore does not only realise some form but reproduces it time and again (the organisation of any living system). Hence autopoietic systems may be termed "self-maintaining". And last not least does re-creation go beyond mere autopoiesis. It not only implies an end but makes it explicit (goals are set) and it not only reproduces the form but creates it (the mode of production of any social system is artificial). Hence re-creative systems may be termed "teleologic" in the full sense of the word and "self-inventive".

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[24] See MAYR 1988.

Thus we can discern degrees of subjectivity. We can depict simple dissipative systems as proto-subjects and simple autopoietic systems as para-subjects while reserving the property of being a subject in the full sense of the word for re-creative systems only. But there is a continuum in the evolution of subjectivity. In this sense the word is true that in the course of evolution by means of ever-higher developed natural systems like social systems nature more and more comes to reflect itself.

And societal evolution is no exception from the rule. With information age societal evolution can be said to approach a point of bifurcation that allows evolution of consciousness to shift to conscious evolution. Jonathan Salk put it already in 1983:

> The most meaningful activity in which a human being can be engaged is one that is directly related to human evolution. This is true, because human beings now play an active and critical role not only in the process of their own evolution but in the survival and evolution of all things. Awareness of this places upon human beings a responsibility for their participation in and contribution to the process of evolution.[25]

Bela H. Banathy adds:

> If we accept this responsibility and engage creatively in the work of evolution we shall take part in a crucial and a first ever event in the seven million years of our evolutionary saga: We shall be the designers of our future, we shall become the guides of our own evolution and the evolution of life on earth and possibly beyond.[26]

These ideas resemble the ideas of the noosphere to come coined by Pierre Teilhard de Chardin[27] and Vladimir I. Vernadsky[28] in the time between world war I and II.

This shift is, so to say, the progressive, upper branch of the great bifurcation of human history and the history of the cosmos as well, the regressive, lower branch of which might end up in decline and decay if humankind is not able to make up with the gap between the technological and the social evolution.

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[25] SALK 1983, 112..

[26] BANATHY 2000, 203.

[27] DE CHARDIN 1975.

[28] See HOFKIRCHNER 1997.

> While our recently emerged communication capabilities created the potential and the conditions for global human community, our consciousness is still locked within ethnocentric, racial, and national boundaries. ... Furthermore, the technological revolution, while giving us an earlier unimagined power, has accelerated to the point where we have lost control over it.[29]

> We have simply failed to match the advancement of our technological intelligence with an advancement in socio-cultural intelligence, and advancement in human quality and wisdom.[30]

The great bifurcation takes the form of the choice between the breakthrough to a higher level of organisation of humankind and its breakdown. Thus we can conclude: praxeologically, in order to open up space for anthropo(socio)genesis as part of the cosmogenesis to turn into noogenesis and to avoid exterminism, humanity requires strategies to master the great bifurcation which is, ontologically, due to the vulnerability of the technosphere, the limited carrying capacity of the ecosphere, and the economic, political, and cultural exclusiveness of the sociosphere and has to be researched by the transversal efforts of the sciences of complexity.

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