THE MUDDLING CONCEPT OF TELEOLOGY

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ABSTRACT. *In this article I study the problematic concept of teleology, taking Aristotle's theory as my point of departure. After more than two thousand years of theological discourse about a creator God, teleology has again been brought into focus in the natural sciences. I bypass the theological phase and study those more recent theories that have similarities to, but also deviate from, Aristotelian teleology. Charles Darwin's theory of natural selection has generated a lively dispute, but some prominent scientists have recently claimed that he re-invented teleology in its non-intentional form, like Aristotle's. More recently a more restricted view of teleology was presented in cybernetics of Norbert Wiener. Then I comment on non-intentional teleology as it has appeared recently in biology, especially in Francois Jacob's tinkering Universe allegory. With regard to the extension of teleology to the study of cosmology, I study Erich Jantsch's self-organizing Universe and Lee Smolin's theory of reproduction of Universes. I conclude by commenting that theories of open-ended teleological evolution thus imply open-ended futures, which we are able to influence.*
KEYWORDS: *teleology, non-intentional teleology, final cause, cybernetics, information, feedback, open-ended evolution, change, learning beings, transcendence*

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Introduction[1]

Since Heraclitus, the most widely accepted principle in science has been that everything is changing. This means that entities are capable both of being changed by external influences and/or of changing by their own initiative, naturally. The former has been discussed in terms of causation and chance. The latter has been discussed as the 'final cause' of Aristotle, and recently as '*self-organization'* (Jantsch 1975, 1980) or, in the case of living beings, '*autopoiesis*' (Maturana and Varela 1980).

An enlightening example of the millennia-long lively dispute about the 'prime mover' – an entity that cannot be moved but is able to move other entities – is the correspondence between Charles Darwin and American botanist Asa Gray. In the wake of the publication of Darwin's '*On the Origin of Species'*, Gray published several articles defending Darwin's views on natural selection against adversary reviewers. Gray simplifies the problem as being between two opposite alternatives – design versus chance – being the cause of change, and does not see Darwin's theory of natural variation and selection to create a third alternative. Gray discusses natural selection in terms of 'necessity', where natural selection interferes with an original design, and wants Darwin to accept the view of God's intelligent design, which he equates with the concept of 'final cause' (Gray 1888:135,138,139).

Darwin, however, was not willing to take such a clear stand for theism. He wrote to Gray:

> Yesterday I read over with care the third Article;[f5] & it seems to me, as before, *admirable*. But I grieve to say that I cannot honestly go as far as you do about Design. I am conscious that I am in an utterly hopeless muddle. I cannot think that the world, as we see it, is the result of chance; & yet I cannot look at each separate thing as the result of Design. . . . Again I say I am, & shall ever remain, in a hopeless muddle. (Darwin 1860: n.p.)

But the concept of final cause is not so simple, if traced back to Aristotle, who discussed it extensively.

1. ARISTOTLE ON FINAL CAUSE

The term *teleology* was coined by German philosopher Christian Wolff in the seventeenth century for the study of final causation. It is now widely accepted as describing goal-oriented behavior, and has already experienced new interpretations, as in cybernetics. (Glaserfeld 1990:128)

Aristotle posed the problem of teleology in terms of final cause. Aristotle was a practical man. He started his studies on simple, well-known phenomena, and only later drew generalizations about more enigmatic ones. Therefore it is no wonder that

[1] Internet files often do not have specific page numbers, and I use expression n.p.(no page). If the year of the source is not given, I mark it as: n.d. (no date). If the name of the author is not given, I mark it as n.a.(no author).

he discussed 'Nature' – which we might call 'Universe' or 'Cosmos' – in analogical terms of human action.

> Now surely as in intelligent action, so in nature; and as in nature, so it is in each action, if nothing interferes. Now intelligent action is for the sake of an end; therefore the nature of things also is so. (Aristotle Physics II, Part 8:n.p.)

For him this was only analogy; he did not sign on to the idea of intelligent design as the cause of natural phenomena. He admitted, that there had to be an original prime mover, which started movement in Nature. The prime mover itself was God, unmovable, complete and good. (Aristotle, *Metaphysics*, Book XII, Part 7:n.p.)

In his thinking, the prime mover only kicked what existed into movement, and after that, the movement of entities follows certain principles. At the same time, from the Biocosmological point of view (Khroutski 2013), Aristotle's Nous is essentially the attractor, i.e. not merely a pushing ruler but the Cosmist Centre of Attractivity – for all the actual things and their inherent teleodriven causes (forces).[1] At any rate, the Movement is the basic mode of change, the other two being change of quantity and quality. Aristotle divided existence into human made artifacts and natural entities,

> which may cause a change in themselves in virtue of a concomitant attribute – it lies in the things themselves (but not in virtue of what they are). 'Nature' then is what has been stated. Things 'have a nature' which have a principle of this kind. Each of them is a substance; for it is a subject, and nature always implies a subject in which it inheres. (Aristotle Physics, Book II, Part 1:n.p.)

Here Aristotle distinguishes 'nature' and 'substance', in which it inheres, but also that existing substance is a precondition, without which nature cannot exist. The term 'nature' has, in his view, two meanings. The first is matter, the substance of entities that have, in themselves, the principle of motion or change. The other is that nature is the form of the entity.

> The form indeed is 'nature' rather than the matter; for a thing is more properly said to be what it is when it has attained to fulfillment than when it exists potentially. (Aristotle Physics, Book II, Part 1:n.p.)

The entity has realized its fulfillment when it has developed to its complete form. The final cause exists in all entities as a *potential*, primary to actualization in

[1] For me Aristotle's difficult concept of Nous or intellect as natural property of Cosmos can be understood through the concepts of information, control, learning and evolution, which are discussed later on in this article.

real world. Change, however, is not intentional, guided by some intentional being, but originated from the nature of each entity as what would today be called *self-organization* or *autopoiesis*.

In Aristotle's thinking, a cause has to be previous to a change. He divides causes into four types:

- the material reason is **substance** or material of which matter is made. Thus all entities have their characteristic way of changing: a thing could not become something which was not natural to it.
- the formal reason or essence, which is a model of how matter should be. Thus, for all entities there is a kind of essence which is expressed as the **form** of the matter.
- the **initial reason.** The third of Aristotle's causes, the immediate reason of change, efficient cause, falls in this category. It has been the most accepted idea in science even later on: causation by a former mover or event.
- **the final reason,** which is the purpose or end result directing the change. In all entities there is a natural tendency to develop into a state which is good for the entity, a completed form. This was the final state towards which all entities were striving. (Aristotle, *Physics*, Book II, Part 3:n.p.)

Aristotle agreed that *chance* could also be the cause of natural events, but he did not consider it focal, and left it out from his classification of causes. (Aristotle, *Physics*, Book II, Part 4:n.p.)

Aristotle considered that, if there was an external cause to the change of an entity, the two entities then had to be in contact, in which the mover is also changed. The causation for the two entities thus has a reciprocal or circular character. (Aristotle, *Physics*, Book III, Part 2:n.p.)

Aristotle thus makes distinctions:

- between substance (content) and form, which are both necessary for change. This principle was named *hylomorphism* in the 19th century. (Manning 2014: 2)
- between initial (efficient) reason and final reason; the initial reason is the immediate mover, but the final reason guides how and in which direction the change happens.

All the four causes are present in all events, which change entities either internally, change their position in time-space, or change their relations to other entities. The first two, substance and form, are more like limitations of change. The third is external cause. But the fourth is predominant; Aristotle emphasizes that nature works for the sake of something, and not just coincidentally.

Aristotle did not give a final answer to the problem which bothered both Darwin and Gray: the origin of variation in nature. He only explained why existing entities change as they change. He also accepted the idea that many beings remain incomplete instead of having completed their drive toward perfection. He gave special status to animate beings, which he considered to have senses, to be able to recognize alterations both in their status and in the environment, and even to have consciousness.

2. DID CHARLES DARWIN RE-INVENT TELEOLOGY?

Teleology was, however, thrown out through the back door of science, at latest by the time of Isaac Newton's clockwork Universe. But it has stalked back on several frontiers of science.

James G. Lennox, historian of the philosophy of science, defends the view that Charles Darwin re-invented teleology in biology.

> The concept of selection permits the extension of the *teleology* of domestic breeding into the natural domain, without the need of conscious design. As in domestic selection, the good served by a variation continues to be causally relevant to its increasing frequency, or continued presence, in a population – but the causal mechanism, and the locus of goodness, shifts. (Lennox 1993:417)

Biologist and philosopher Francisco J. Ayala (2007) entitled one article "*Darwin's Greatest Discovery: Design without designer*". In it he also argues that Darwin had a teleological view of biological evolution.

> Darwin accepted that organisms are 'designed' for certain purposes, that is, that they are functionally organized. Organisms are adapted to certain ways of life, and their parts are adapted to perform certain functions . . . But Darwin went on to provide a natural explanation of the design. The seemingly purposeful aspects of living beings could now be explained, like the phenomena of the inanimate world, by the methods of science, as the result of natural laws manifested in natural processes. (Ayala 2007:8567–8568)

According to Charles Darwin's son Francis, Darwin himself agreed with the teleological view (Darwin, F. 1887:308, op.cit. Lennox 1993:409). But among his successors there has been lively debate about whether Darwin rejected or accepted the idea of teleology. I that debate, however, teleology was understood as intentional action of the creator God: if the intelligent creator was not accepted as the source of teleological causation, the view was considered non-teleological. (Lennox 1993)

What causes confusion is the ambiguous use of the term 'design'. It has been used to refer both to the action of an intelligent creator and to the final result of the design process. In the quotation above, Ayala uses quotation marks to indicate that the term 'designed' is not exactly accurate to describe the character of organisms. He specifies that organisms "are functionally organized", and concludes that Darwin provided a *natural* explanation for 'design'.

One novelty in Darwin's teleological thinking was that he changed the focus from being solely on the biological organism itself to studying its relationship and its adaptation to its environment.

Another thing foreshadowed by the dispute about Darwin and teleology: his natural selection theory moved the emphasis from the classification of living beings to the study of change, events, processes, and connections, to *evolution*. This happened nearly a century before cybernetics and systems theory brought the idea of evolution back into many branches of science.

3. TELEOLOGICAL BEHAVIOR OF SYSTEMS

The article "*Behavior, Purpose and Teleology*", by Arturo Rosenblueth, Norbert Wiener and Julian Bigelow, is deemed the first public forum to have presented the principles later given the name *cybernetics*. It was published in *Philosophy of Science*, 10(1943), pp. 18–24. Here my source is an offprint published on the internet page *Principia Cybernetica Web*.

The authors introduce what they call a behavioristic approach to the study of systems. The emphasis is on studying the output of a system, and the relationship of the output to the input. Output is defined as any change the system produces in its environment or any modification within the system itself that can be detected externally. Input is any external influence that changes the system. (Rosenblueth et al 1943:1)

Their focus is on the energy the system itself produces or has stored, which is involved in a specific reaction. Thus their object of study is the active behavior of the system. The writers divide active systems into two classes: purposeful and purposeless. Purposeful systems are directed toward attaining a goal, while purposeless systems are not. Their interest is in active purposeful systems. They define the Aristotelian final state as follows:

> a definite correlation in time or in space with respect to another object or event. (Rosenblueth et al 1943:1)

Their view differs from Aristotle's in that they do not see the "final cause" to be a necessary, determined cause, but they do presuppose that this kind of system has volition, a choice of purpose.

> The basis of the concept of purpose is the awareness of *voluntary activity*. Now, the purpose of voluntary acts is not a matter of arbitrary interpretation but a physiological fact. When we perform a voluntary action what we select voluntarily is a specific purpose, not a specific movement. (Rosenblueth et al 1943:1)

Aristotle did not speak directly about information. Rosenblueth, Wiener and Bigelow instead made information a focal concept in their theory. They stated that not only were animate beings able to sense information about their behavior and its results, but some machines could do that too. The concept of *servo-mechanism* was coined exactly to describe machines having ability to sense and control their behavior. This means that a teleological system requires a special control mechanism that is able to receive information and control system behavior. Information received about the activities of the system and its results was named *feedback*. (Rosenblueth et al 1943:2)

Their theory is more limited than Aristotelian teleology: they consider as teleological systems only those that are capable of using continuous feedback. A system also has to be able to apply received feedback, to learn. The study of such systems was later named *cybernetics* by Norbert Wiener. They also created a kind of hierarchy of teleological systems: more primitive ones cannot predict the behavior of their environment, but more advanced ones can. Because their thinking is restricted to a natural, scientific approach, they call this ability *extrapolative*.

The hierarchy is then formed, so that each more advanced system has the abilities of lower ones plus something more.

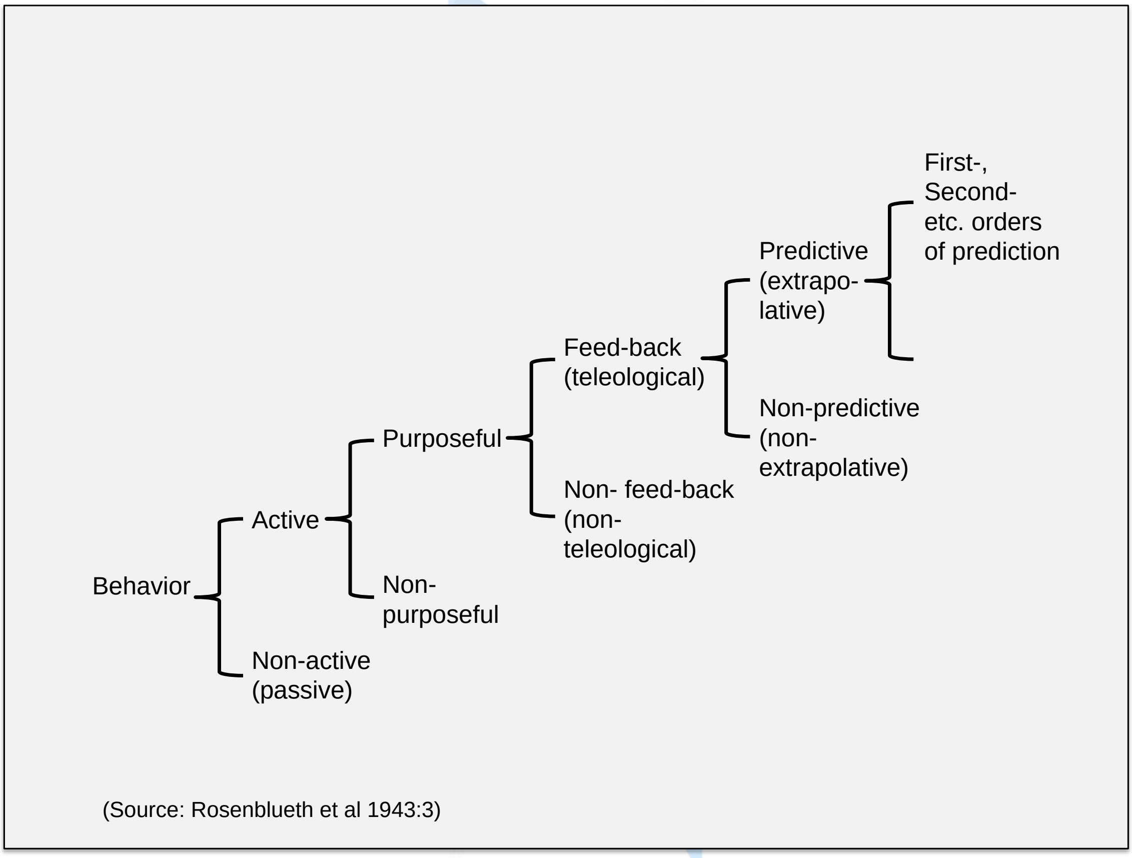

Figure 1. Rosenblueth-Wiener-Bigelow (1943:3) – Classification of system behavior

4. NORBERT WIENER AND CYBERNETIC SYSTEMS

Wiener implicitly agreed with Aristotle regarding the first two reasons, substance and form. In his theory, the 'order of things', mediated and changed by utilization of information, was decisive in the movement of systems, and consisted of unified change of order/form and substance, hylomorphism.

Regarding the second two reasons for change, his theory includes the possibility of **choice** in controlling an entity's behavior and its surroundings. Wiener's cybernetic causality is then typically teleological, but it differs from Aristotelian general teleology because it has an intermediate variable, choice, which manifests itself as decision-making. Decision-making is not only a characteristic of human beings, but encompasses all *learning beings*, from living beings to teleological machines. To exercise choice, cybernetic systems have special control mechanisms. They consist of sensors or senses to receive information and units capable of interpreting information to control the behavior of the system. Wiener considers messages themselves to be a form of pattern or organization, information being the touchstone of organization. (Wiener 1961, 1989)

> It is my thesis that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback. Both of them have sensory receptors as one stage in their cycle of operation: that is, in both of them there exists a special apparatus for collecting information from the outer world at low energy levels, and for making it available in the operation of the individual or of the machine. In both cases these external messages are not taken *neat*, but through the internal transforming powers of the apparatus, whether it be alive or dead. The information is then turned into a new form available for the further stages of performance. In both the animal and the machine this performance is made to be effective on the outer world. In both of them, their performed action on the outer world, and not merely their intended action, is reported back to the central regulatory apparatus. (Wiener 1989:26–27)

Wiener based his theory on the most general level of the presupposition that Universe is, according to the second law of thermodynamics, proceeding towards complete entropy, '*heat death'*, but there are enclaves where learning beings strive towards better order, '*negentropy'* or *'syntropy*'. Also humans as learning beings can thus intentionally try to create more order. Wiener repeats the idea of heat death several times, but it seems only a backdrop upon which his concepts of information, order, control and communication can be projected. (Wiener 1989:8,12)

Wiener's cybernetics is more restricted than Aristotle's general teleology; Wiener studies only intentional teleological systems, not non-intentional natural processes. Action can be directed toward parts of the system, toward the system as a whole, and/or toward its environment. In addition to intentional action, unintended events and processes can also happen which are caused by the inner dynamics of the system, resulting from the self-organization of the parts or the whole.

The ability to control system behavior and act teleologically leads to the phenomenon of *emergence*, the birth of new kind of wholes that can be more complex and more self-controlling than earlier ones.

Self-organization is natural in all cybernetic systems. They direct their action toward goals, but the results of their action may not necessarily fulfill those goals, but do something else. However, cybernetic systems have the ability to learn and change their behavior – with the help of feedback – to be better at achieving goals. They are not perfect.

Thus a cybernetic system as a whole is an open system, which has control units able to utilize information as feedback loops in its internal change and its influence on the environment. Single elements can move themselves, or a group of elements, or the whole. These movements constitute change, which can be either intended or unintended. The change occurs as events and processes, when the process is more or less continuous movement toward a goal.

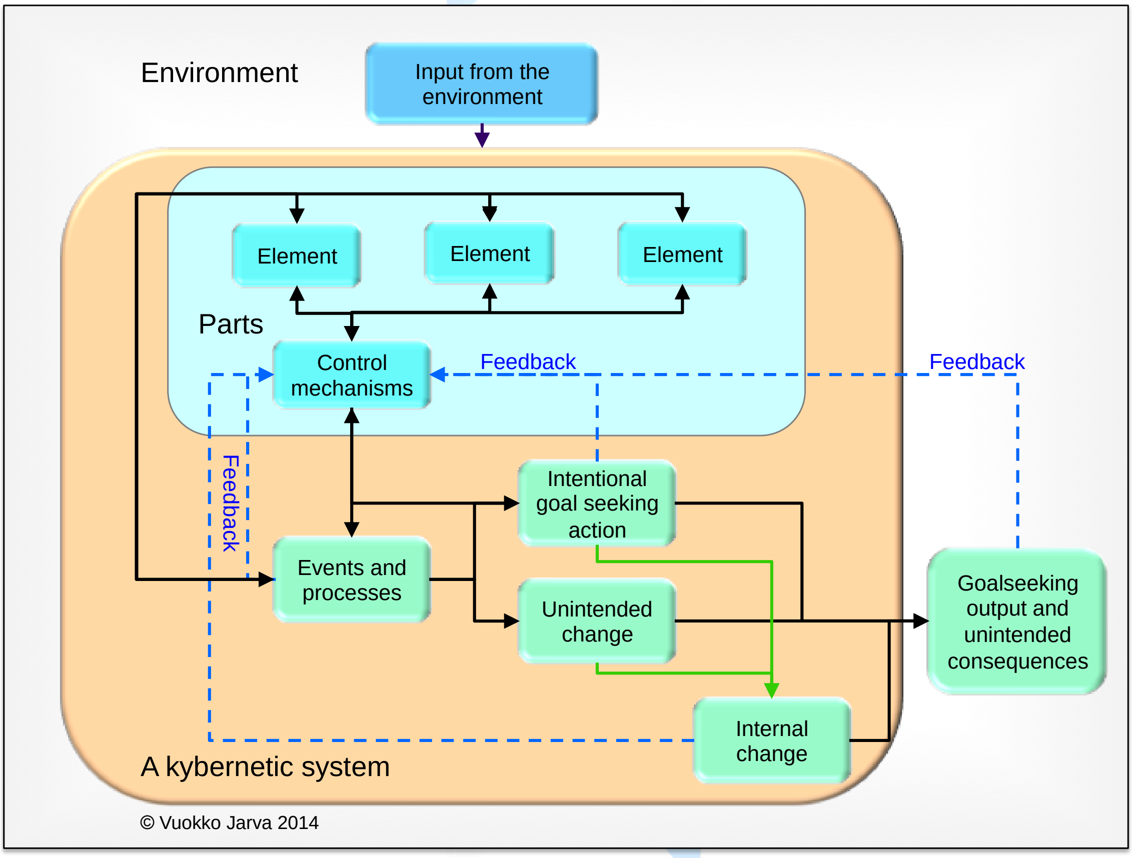

Figure 2. A general description of a cybernetic system

Cybernetic systems undoubtedly belong to the teleological sphere. But not all systems are cybernetic. The preconditions of being cybernetic are:

- internal goal-seeking behavior, intentional teleology,
- implemented by control mechanisms able to sense and control system behavior using feedback, and

• openness to influences coming from outside.

What makes cybernetic systems imperfect is caused by limitations in either the substance or form of the system, by internal mistakes in exercising control, or by obstacles caused by the system's environment. Even if the dominant factor in the change of cybernetic systems is their ability to control their behavior, they do not exist in a vacuum, but are open to influences coming from their environment. But the environment does not influence them mechanically; they are able to transform incoming influences and adjust their behavior. They are able to learn. Biological organisms are the archetype: they follow a genetic program, but are able to learn.

5. BIOLOGY AND NON-INTENTIONAL TELEOLOGY

Natural non-intentional teleology produces, not design, but 'functional organization'. Allen McNeill refers to Andrew Woodfields' (1976) view that all teleological descriptions can be compressed as the expression "x happens *in order to/for* y outcome." (McNeill 2011:n.p.). So the results of teleological processes are, in biology, functional parts of organisms. They serve specified functions, participating in the survival and reproduction of the whole organism. There has, however, been a shift of emphasis in evolutionary biology. Aristotle's definition of the final cause as the "good" of an individual entity has been extended to cover the good of the species. The good, the well-being, of an individual organism has lost its focal importance.

There does not seem to be much disagreement among biologists about survival and reproduction as the ultimate final causes, which the functional parts of the organism serve (Ayala 2007:8569).

There is, however, disagreement on what initiates variations which are then tested by natural selection. Nobelist Jacques Monod (1973:120–121) posits the permanence of species and calls phenomena that bring changes to this straight line *accident*. Monod's idea about the conservativeness of life is based on the improbability of gene change. To confirm this, Monod gives examples of some species that have remained unchanged for millions of years. (Monod 1973)

Monod's partner in winning the Nobel Prize, Francois Jacob, presents a different view:

> The appearance of new organisms is a result of a long competition with each other conflicting life processes – it is a result of fighting powers, it is a result of the conflict between the organism and its surroundings. In this process, however, the organism itself has the floor first. (Jacob 1972:182)

Jacob defends the view that the organism itself can be the cause of change. If life itself is conservative, the source of change must come from outside. That hypothesis, however, does not take into consideration one central step in the evolutionary process: sexual reproduction. The reproduction of organisms is based on a genetic program which is able to produce an organism similar to the parent organism — but not exact copy. Sexual reproduction produces new organisms from the interaction of two genetic programs. (Jacob 1972:328)

Sexual reproduction causes change as *invention*, *emergence*, to become the rule; it is no longer an exception. The creation of an organism with new qualities can be explained through the process of reproduction itself, and a source of variation outside the organism is not needed for explanation. Sexual reproduction becomes the main evolutionary force. Of course this does not mean that genetic mutation disappears; rather, it loses its central importance.

Biologist Allen McNeill lists fifty processes that produce variation, and random mutation is only one of them. Most of them are neither random nor mutations. He divides these 'engines of variation' into 11 subclasses of which only one is random mutation, and one is influence of the environment; others involve the organism's internal self-organization. (McNeill 2007:n.p.)

5.1 Francois Jacob's tinkering Nature

The idea of transcendence, the ability of life to exceed itself, is strongly stressed by, among others, Huxley (1970), Dobzhansky (1971) and Jacob (1972, 1977). Dobzhansky says: "The reaching of a new dimension or level is in any case the critical point of evolution history." (Dobzhansky 1971:57–58). Jacob writes:

> Natural selection is the result of two constraints imposed on every living organism: (i) the requirement for reproduction, which is fulfilled through genetic mechanisms carefully adjusted by special devices such as mutation, recombination, and sex to produce organisms similar, but not identical, to their parents; and (ii) the requirement for a permanent interaction with the environment because living beings are what thermodynamicists call open systems and persist only by a constant flux of matter, energy, and information. (Jacob 1977, 1163)

What then is evolution if not continuous directedness towards a perfect goal? Francois Jacob argued strongly against the perfection of evolution. He points to Darwin, who in his view repeatedly emphasized the imperfectness of evolution. (Jacob 1977:1163)

Apparently, even if evolution is non-intentional, human activities provide useful analogies. Aristotle compared the activity of nature to an artisan. Jacob compares evolution with tinkering, the creative use of the materials available to create something which gets its form during the process, not as the result of an earlier plan or design: during the process the tinkerer finds the potentials of the available materials and utilizes some of them. (Jacob 1977: 1163–1164)

In Jacob's view first comes the inventive and creative process of producing a novelty, *transcendence*. The results of tinkering are then tested by natural selection, which finally shows which of the results of an imperfect creation serve the survival and reproductive capacity of the species. Jacob thus describes a process of evolution: the emergence of novelties. McNeill's 50+ processes that cause the creation of novelties give more exact information about how it really happens. There also is a connection to the theory of cybernetics: all organisms are cybernetic systems, able to sense information, learn, and use it to control the behavior of the organism. But there remains still the problem of general teleology, the problem of the directedness of evolution. Jacob has as answer:

> Evolution does not produce novelties from scratch. It works on what already exists, either transforming a system to give it new functions or combining several systems to produce a more elaborate one. (Jacob 1977:1164)

He describes 'tinkerer' as nature, which indicates that the cause of change is internal to the organism, not external. In this he agrees with Aristotle. He also adds something interesting to the theory of natural selection: he discusses it in terms of opportunity to choose.

> As Simpson (4) pointed out, the interplay of local opportunities – physical, ecological, and constitutional – produces a net historical opportunity which in turn determines how genetic opportunities will be exploited. It is this net historical opportunity that mainly controls the direction and pace of adaptive evolution. (Jacob 1977:1166)

Biological evolution has, in his view, a more general teleological aspect than only survival and reproduction of individual organisms and species; it has a tendency to create more elaborate systems.

6. IS THE UNIVERSE'S EVOLUTION TELEOLOGICAL?

As has been discussed above, non-intentional processes in biology can today also be counted as teleological. But phenomena which do not belong to living beings and, as cybernetics has shown, to teleological artifacts – are they then teleological?

The idea of an asymmetrical arrow of time was a fairly late invention. It had been implicitly present in Charles Darwin's theory of evolution and in Lord Kelvin's and Rudolf Clausius' (among others') studies on regularities in thermodynamics. British astronomer Arthur Eddington invented the term; he had noticed that there was a one-way-only direction of natural events. (Price 2010:1)

Here it is important that there can neither be time without space, nor any space without time, the relationality principle. But there is a third thing which was revealed by relativity theory: the center of gravity moved from absolute time and space to *events*. Bertrand Russell characterizes the change brought by relativity theory by commenting that the world represented to us by relativity theory more concerns events than 'beings'. (Russell 1960:174)

Thus Einsteinian physics led back to what Aristotle had already stated about the relationship of time and change. Philosopher Bradley Dowden comments that Aristotle held "time is the measure of change", but not change itself.

> In developing his views about time, Aristotle advocated what is now referred to as the relational theory when he said, "there is no time apart from change…." (*Physics*, chapter 11). In addition, Aristotle said time is not discrete or atomistic but "is continuous…. In respect of size there is no minimum; for every line is divided ad infinitum. Hence it is so with time" (*Physics*, chapter 11). (Dowden 2013:n.p.)

The core of these observations is that space, time, entities and change form wholes. Below I comment upon some theories which deal with the Universe as a whole, and have developed the concept of teleology further. All the following theories are based on the asymmetry of time, the concept of open ended evolution, and internally caused self-organization of entities.

6.1. Erich Jantsch's self-organizing Universe

A general and courageous view of self-organization is Erich Jantsch's theory of the self-organizing universe. His theory unifies the self-organization of the whole of the Universe, its non-living entities, organisms, human development, human communities and even consciousness. Here I comment only on the parts dealing with the non-living Universe, but one must remember that, in his view, there is interaction among all the entities of the Universe. Living beings also influence non-living ones, as James Lovelock (Lovelock and Epton 1975; Lovelock 1979) has described in his Gaia theory.

Originally astrophysicist Erich Jantsch based his theory of the self-organizing Universe on Ilya Prigogine's concept of *dissipative systems*, systems that are far from thermodynamic balance.

In Jantsch's theory, all the systems of the Universe which are connected to their environment are open systems; thus, they are able to exchange energy and matter with their surroundings, and are capable of change. Transitions are irreversible; thus, they break the time symmetry between past and future. (Jantsch 1980:27)

Jantsch bases his idea of self-organization on the principle that systems develop because of the dialectical tension of order and disorder in them. Order stabilizes a practice, which is broken by disorder when order has reached a defined level. Thus his work belongs in the family of non-intentional teleology theories, but also in the family of dialectical theories. His theory holds teleology to be the directedness of the unified self-organization of the Universe toward more complex and more organized units. (Jantsch 1975,1980)

> The central aspects of the emerging paradigm of self-organization are: *primo*, a specific macroscopic dynamics of process systems; *secunda*, continuous exchange and thereby co-evolution with the environment, and *tertia*, self-transcendence, the evolution of evolutionary processes. (Jantsch 1980:9)

Jantsch accepted the hypothesis of a big bang as the beginning of the Universe. After that beginning, systems developed through decombination and decoupling. At some level even more complicated systems appeared that were able to maintain their state and reproduce: life emerged. Life started to influence non-living matter and these two aspects of existence have since then been developed by interaction. This view of the evolution of the Universe embedded the concept of information.

Jantsch also subscribes to the ideas of choice and learning:

> Evolution, at least in the domain of the living, is essentially a learning process. A more subtle view of self-organization dynamics recognizes the degrees of freedom available to the system for the self-determination of its own evolution and for the finding of its temporary optimal stability under given starting conditions (Nicolis and Prigogine, 1977; Eigen and Schuster, 1977/78). Evolution is open not only with respect to its products, but also to the rules of the game it develops. The result of this openness is the self-transcendence of evolution in a “metaevolution”, the evolution of evolutionary mechanisms and principles. (Jantsch 1980:7–8)

Jantsch’s self-organizing Universe strongly defends the view that the whole Universe is not evolving toward more entropy, but toward more organization. This happens through recurring spatial and temporal *symmetry-breaks*. The arrow of time does not lead toward heat death, but toward more specific and more elaborate systems – as Francois Jacob stated regarding biology. In Jantsch’s view, even the open-ended Universe is teleological.

6.2. Lee Smolin and the reproduction of the Universes

The uniqueness of the Universe has until recently been a central doctrine both in physics and in religion. Modern physics has transformed this concept such that the beginning of the Universe was a big bang. But physics does not tell us what came before the big bang, which did not have an external designer, but the big bang was a property of the Universe itself. It is not clear whether physicists think that there is an absolute end to the Universe, but at least there is a partial analogy to fate of a star: it expands, then collapses. A collapse happens as well when all the stars close to a black hole fall into it.

Recently the uniqueness of the Universe has been questioned by physicists Roger Penrose, Vahe Gurzadyan and Lee Smolin. Based on their observations on background radiation, they suggest the theory that the Universe goes through recurring cycles of development. (Gurzadyan and Penrose 2010; Penrose 2010)

Penrose and Gurzadyan base their view of a cyclic Universe strictly on observations in physics. Lee Smolin goes further and takes a more philosophical point of view. He agrees with the idea of a Multiverse as a temporal process: one Universe is born from a Big Bang, but its development reaches a certain phase and it collapses into black hole, which again gives birth to new Universe. There is more than one black hole, so there can also be parallel Universes. Thus the Universes reproduce through black holes, and in that process create variation. (Smolin 2006, 2013a, 2013b)

What is specific in Smolin's theory is that the development of Universes follows the procedure of natural selection. This process is both creative and restrictive. Even the so-called laws of nature can change during the natural selection process. His theory is based on relativity and relationality; a solid background, unmovable entities, and unchanging relationships do not exist. He claims that this was the greatest invention of both Darwin and Einstein as compared to earlier theories in biology and physics. (Smolin 2006)

Thus Smolin confirms temporal asymmetry in the case of a single Universe, but he does not take a stand with regard to the entire process of the Multiverse. In accepting natural selection, however, he accepts the idea of non-intentional teleology in the case of a single Universe.

7. WHAT THEN WOULD BE NON-TELEOLOGICAL?

Aristotle's concept of final cause was a blanket principle embracing all the entities in the Universe. He accepted that the imperfection of the teleological process meant that it would not always result in a perfect, completed entity fulfilling all of its potential. The main categories of non-teleological events can be classified as follows:

Chance based change. Aristotle mentioned that some changes can be caused by chance, even though he did not analyze them in detail. In cybernetic teleology, there is a lot of space for chance. Chance has actually been imported into modern science as statistical probability. One recent writer is Nassim Taleb, whose book *The Black Swan: The Impact of the Highly Improbable* (2007), raised a lively discussion about non-predictable random events.

Mechanistic devices. Rosenblueth, Wiener and Bigelow (1943) state that purposeful mechanistic devices are not teleological if they cannot utilize feedback information about their actions. Even Newton's clockwork Universe would belong to this category.

Nature's production of variance. Aristotle's principle of teleology has been confirmed in biology as DNA and RNA genetic codes, which control the development of living beings. DNA and RNA are, however, like Jacob's tinkerer: they do not guarantee the perfection of the final result.

Conclusion

In this article I have reviewed the concept of teleology, taking as my point of departure Aristotle's theory of general teleology. I have chosen Charles Darwin and Norbert Wiener as pace-setters for the modern concept of teleology. Non-intentional teleology has been enriched by natural selection, information, and internal control mechanisms of living beings and – according to some pioneers of cosmology – even all of the Universe.

For all practical purposes of human action, the main conclusion is that teleology has been accepted as a general principle of evolution by prominent forerunners of modern biology and cosmology. New modes of teleology are, however, non-intentional and open ended, which means that there is no pre-written manuscript, and that evolution follows the imperfect, 'tinkering' principle. Emergence of novelties is the first step, which is then followed by natural selection. In this view, the future is open, and it is possible to influence it by human action.

At the same time, Aristotle's original "general teleology" (and its rehabilitation) which establishes the primary significance of the naturalist inherent teleodriven causes – is another grand purpose (and direct aim for futurologists) for contemporary humankind activity and cultural scholarly development (including our contributions to the scholarly endeavors of the Biocosmological Association).

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