Systems Philosophy and Cybernetics

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Abstract[1]

The general purpose of this article is to outline the intellectual importance and the pragmatic value of Cybernetics Philosophy. With this orientation, we will try to show the plausibility that Cybernetics, in its essence, is not new but, on the contrary, it seems consubstantial with human nature and, plausibly with Nature itself. Based on this plausibility, we will try to reason why it is intellectually important and pragmatically valuable, to foster reflections oriented to a Philosophy of Cybernetics. Consequently, we will suggest that applying systems philosophy, to be applied to Cybernetic systems, as a species. Additionally, it would be required to identify the differentia specifica of cybernetic systems and, hence, add other predicates to the notion of Cybernetics. This does not mean that we will be suggesting the use of the Aristotelian Definition and adding another definition to the overwhelming number of definitions that already exist. What we are suggesting is to use the Aristotelian notion of 'definition', in a more comprehensive context, i.e., not to define but to describe the notion or the idea of Cybernetics. In this context, we suggest the support of 'Control Philosophy' as a source to identify the differentia specifica of "cybernetics" in the context of the genus "general system". This suggestion will emerge as we provide details regarding the con-essential nature of cybernetics to human beings and potential with Nature and its Evolution.

Based on the details, we will provide regarding the above paragraph, we will suggest cybernetic relationships that tacitly, implicitly, or explicitly exist between the most important notions; which we will provide as related to the general-purpose briefly described above. To do so, we will try to get intellectual support from Lonergan's cognitive levels. We will also, 1) briefly describe the relationships between Lonergan's cognitive levels and important cybernetic notions; and, then, 2) use Lonergan's terms and notions in order to increase the precision parts of the following sections. The latter would show the importance of Lonergan's Philosophy as intellectual support for a Cybernetics Philosophy. This is because Lonergan's intellectual perspective is a cybernetic one in both First and Second-Order Cybernetics.

1. Introduction

As a consequence of what we briefly described in the abstract, we will identify in this article potential relationships between Systems Philosophy and Cybernetics that would probably support a suggestion regarding what may be called meta-holistic perspective by means of identifying cybernetic relationships between the wholeness, proposed by systems philosophy, and its opposite, frequently called reductionism. At another level, a meta-holistic perspective would cybernetically relate ontological/epistemological holism, with different kinds of atomism/reductionisms.

The basic idea of this meta-holism is based on relating holistic thinking with its opposite in the context of a larger Whole, by means of identifying cybernetic relations between opposites that may be conceived as polar opposites, i.e., requiring each other to be defined and/or to exist (instead of excluding each other, as would be a case of opposition by contradiction.)

This will also be based on identifying cybernetic relationships between analysis and synthesis (meta-synthesis), thinking and doing[2], abstraction and concretion, etc.

We will also suggest a meta-synthetic perspective between analysis and synthesis. This will be approached by identifying cybernetic/systemic relationships between them, because they may be conceived as polar opposites, i.e., not contradicting, but requiring, each other. Similarly, we will base this article on other systemic/cybernetic relationships as, for example, abstractions/concretions, thinking/doing, etc.

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[2] We are using terms "thinking" and "doing" in their most general and etymological meaning, i.e. "think" as "imagine, conceive in the mind; consider, meditate, remember; intend, wish, desire"; and "do" as "perform, execute, achieve, carry out, bring to pass by procedure of any kind" (Online Etymological Dictionary), This allows us to use the terms "thinking" and "doing", as parallel processes, requiring each other and even containing each other. This parallelism allows them to have continuous cybernetic loops. Actually, thinking is an internal, mental, doing, and doing may refer to internal or external action. Thinking is based on our past doings, perceiving and knowing. The later depends on doing as well. Perceiving depends, partially, on what we do. Thinking/doing, in parallel is how human beings interact with their internal and external environments (Nature, Society, etc.). With this meaning, "doing" would be the genus of internal and external action and, consequently, is among what relates our mind activity with our external actions and interaction.

1.1. Nature of this Article

This article is mostly based on *abductive reasoning* and this is one of the reasons why we characterize it as an *essay*. It is also based on

1. Jeremy Horne's notion of "research" (The Philosophy of Research, 2019), especially regarding

   "One of its etymological meaning, "1590s, from Middle French recercher, from Old French recercher "seek out, search closely," from re-, intensive prefix (see re-), + cercher "to seek for," from Latin circare "go about, wander, traverse," in Late Latin "to wander hither and thither," from circus "circle" (see circus). Related: Researched; researching … No doubt, the non-brain-dead person will recognize "answers produce more questions", an oblique reference to the wandering and ultimately the circle in the etymology of "research". A lot of **circularity** and its creative aspect, ***spiraling***, have to do with the language. Once we know their nature, a starting point for research can be found, as well as the answer to what it all means. Keep in mind Socrates and the meaning of philosophy, the love of wisdom. "Starting point" implies working towards learning about the order giving rise to the phenomenon you are investigating. Your research for "wisdom" will obtain a substantive answer about meaning."

2. Practice-based research, where research and practice (including consulting) were explicitly related via cybernetic relationships. Mostly a combination of the following cybernetic methods or methodologies supported the way we related *understanding and practice*: Research via consulting, consulting via research in the context of combining Action-Research, Action-Learning, and Action-Design (all of which are cybernetic methods), applied in the management of more than 100 projects of software-based information systems that nurtured, intellectually and pragmatically, the design of a comprehensive General Systems Methodology. Most of these systems were implemented and used for several years. Six of them have been maintained and used for 25 years and more. In our opinion, this was because of adequate support from adequate cybernetic relationships with the systems' users and their managers[1]. This is empirical evidence, for us, regarding the pragmatic usefulness of systemic & cybernetic methodologies that are strongly based on Systems Philosophy and General Systems Theories (GST). We are specifically referring, here, to the first GST that was described by the

Biologist and Philosopher Ludwig Von Betalanffy (General System Theory: Foundations, Development, Applications, 1968). We provided conceptual and methodological details on a General Systemic/Cybernetic Methodology (Callaos N. , 1995/2020) based, mainly, on a combination of 1) The Systems Approach and Philosophy, basically, (Von Bertalanffy, 1968), (Churchman, 1971), (Ackoff, Scientific Method: Optimizing Applied Research Decisions, 1962), (Laszlo E. , 1972), etc. and 2) several authors on Cybernetics, mainly, (Ashby W. R., 1956), (Pask, 1961), (Trappl, 1983), (Tsien, 1954), etc.

Half of the above-mentioned books are based on methodological theory and design and the other half is related to the applications of the proposed systemic/cybernetic methodology to different knowledge fields and to different academic and professional projects. These projects included corporative information systems development, in which about 98% of "lines of code" were used and maintained for, at least, five years. Some of them are still being used and maintained after 25 years, of being developed and implemented. This adaptability is, in our opinion, strong empirical evidence of the effectiveness of the systemic-cybernetics methodology used. This is especially true if we take into account what has been called the Software Crisis where just about half of software development projects are successful, let alone being used for 5-25 years.

1.2. Empirical Effectiveness of the Systemic-Cybernetic Methodology, Reinforcing the Experience on which this Article is Based.

Figure 1 shows the statistics of the Standish Group in the period 1995-2015 years, regarding the percentage of the software development projects that succeeded, failed, and challenged (not completed according to the expectations and far from the initial estimations). Consequently, to refer to a systemic/cybernetic methodology with which more than 80% of the lines of code were used for at least 5 years seems a huge exaggeration, if not a blatant lie. But, we have proof, via legal documents (fulfilled contracts) and the number of systems and lines of codes that have been in production for 25 years.

Our intention here is not to sell our services because we closed this consulting firm. Our intention is to assure the reader about the effectiveness of systems/cybernetic methodologies: not just cybernetic and not just systemic, but also applying System Philosophy to the design

of the development methodology. The problem is not a technical one but a methodological, conceptual, notional, psychological, ethical, and co-educational. Developers and users should be trained in each other's semiotic system. This is why very initial prototypes are the best means to discover, before it is too late, errors in translating from business semiotic system to software development semiotic System.[ii]
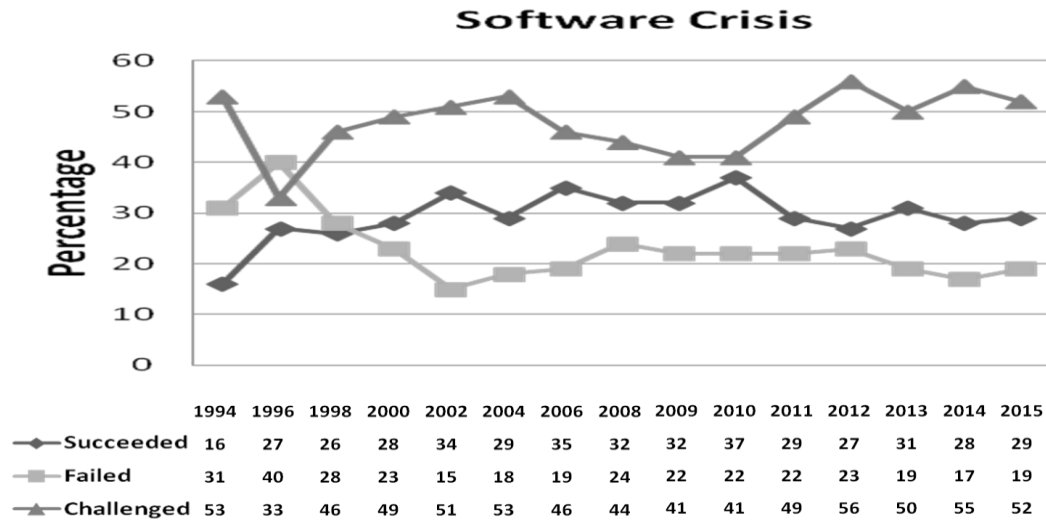
Software Crisis

	1994	1996	1998	2000	2002	2004	2006	2008	2009	2010	2011	2012	2013	2014	2015
Succeeded	16	27	26	28	34	29	35	32	32	37	29	27	31	28	29
Failed	31	40	28	23	15	18	19	24	22	22	22	23	19	17	19
Challenged	53	33	46	49	51	53	46	44	41	41	49	56	50	55	52

Figure 1: Statistics of the Standish Group in the last 18 years. It is evident that there has been no meaningful improvement since the phrase "Software Crisis" was coined in 1968.

Source: The Standish Group: Chaos Summary for 1994-2015. Collected from several Standish Chaos reports, e.g. (Lynch, 2015), (The Standish Group International, Incorporated , 2012), (The Standish Group International, Incorporated , 1995) and (The Standish Group International, Incorporated, , 2013)

One of my very personal[3] conclusions, based on 30 teaching and developing real-life information systems, is that the student should be educated in an

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[3] I am **not** going to avoid the use of the first pronoun, because 1) from a systemic perspective subject and object are strongly and intrinsically related, 2) Second Order Cybernetics changed the notion of "observing the observed" to "observing the observing system", i..e "observing the observed and the observer"- This requires reflexive thinking (writing and reading) and not just interpretation of what has been observed, and 3) I found no way to refer to implicit knowledge (generated by experience), not using the first pronoun, and being intellectually honest with the reader. I think these three reasons weight more than some established standard regarding writing academic, scholarly and research paper. I am not going to refrain from providing opinions, because they are part of reflexive thinking, writing and reading, but I will alert the reader each time I give an opinion, making it explicit that is an opinion. I never found a way isolate episteme from doxa, nor vice versa. Episteme and doxa support each other though frequently in an implicit way. Mathematical knowledge, for example, is supported by initial axioms which, by definitions are not "justified beliefs". Empirical sciences are based on the idea that the suture would be similar to the past and there is no scientist with a window to the future. So, this is another not-justified belief, as David Hume masterfully showed to anyone willing to see.

updated and updated Ethos, Pathos, and Logos; which is more necessary than what many can imagine. How would the relationship with the users and their managers if the software engineers did not have Ethos, Pathos, and User's Logos, besides computing Logos? This topic is a large one and a book is being written on it. Our intention here is to emphasize the importance of both a Systemic (not be confounded with systematic) and cybernetic methodology. This requires information, knowledge, real-life experience, and education (not just training). A cybernetics methodology should include cybernetic relationships between thinking and doing. If these relationships are explicit to the developer or future development, they would be more effective. But it also should be a systemic development, i.e., the developers should be related to the users dialogically, ethically, emotionally, and verbally. They should know and understand that they are part of a whole larger than them. This whole is, in turn. The intersection of at least two wholes: that of their organization and the users' organization. We are just trying to inform in a few words what we mean by systemic/cybernetics and the importance, even the necessity of relating. Conceptually, Cybernetics would be part of Systemics, but in reality, both fields intersect each other. This is why it is important in our opinion to explicitly differentiate them in order to adequately relate them. This may explain the reason for the following sections, diagrams, and figures.

1.3. A Systemic-Cybernetic Thinking and Writing

The briefly described experience, above, supports why the main purpose of this article is to show the ***intellectual importance and pragmatic usefulness*** of a Philosophy of Cybernetics and, more specifically, applying Systems Philosophy to the specific case of cybernetic systems. We will also try to provide some pointers of System Philosophy oriented to a possible Cybernetics Philosophy.[4]

Parallel and lateral thinking should be part of systemic thinking and *non-linear thinking* should be part of cybernetic thinking. The first is required because each part is systemically inserted in a larger Whole; which, as such, may have emergent[5] properties, not present in any of its parts. It may also

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[4] Sometimes the notion of "Systems Philosophy" is interchanged by the phrase "Philosophy of Systems". But this is not necessarily correct. The latter is included in the former. For example, the latter is called "systems metaphysics" as part of "Systems Philosophy" by Laszlo (1971, p. 295) and "systems ontology" by von Bertalanffy (1968, p. xxi), also as part of "Systems Philosophy".

[5] We are aware of the huge controversy that exists in Science and especially in Biology regarding the validity of the notion of "Emergence" and "emergent properties" and "emergentism". This is not the place to deal with this controversy, but we may declare that we are on the side of reality of "emergent properties" (at least regarding the epistemological perspective), but we certainly are not oriented by "emergentism" because of the same reason we are not oriented by "reductionism". We

be related to other parts, systemically inserted in the same larger Whole. A similar situation may happen to any system because it is always, implicitly, or explicitly inserted in another larger system. Cybernetic thinking requires an adequate combination of linear and nonlinear thinking

Consequently, systemic-cybernetic thinking may require a combination of parallel, lateral, linear, and non-linear *thinking*. If this is so, then how should be written the product of systemic-cybernetic thinking, especially when it is related to systemic and/or cybernetic *doing*. The more a writer would like to represent her/his thinking processes in trying a similar kind of thinking in the reader, the more s/he would like to present chunks of the flow associated with her/his thinking/doing. This certainly, would be more advisable from a Second-Order Cybernetics perspective. This would allow the reader to have the possibility to observe the observing system and not just what the author as the observer is trying to describe in the article.

This is one of the reasons why we will try to represent in this article a combination of linear and non-linear thinking. This would allow descriptive jumps from parts and sub-systems to the system, i.e., a more comprehensive Whole.

Furthermore, linear thinking is, frequently, part of a more comprehensive nonlinear, cybernetic thinking. And vice versa, nonlinear thinking is frequently (explicitly or implicitly) inserted in a more comprehensive linear thinking. This is, actually, the basis of the "essay and error" method used in science, engineering, design activities, writing, etc. Even Mathematics combines non-linear and linear thinking. Mathematical thinking is supported by backward thinking (mathematical analysis) and forward-thinking (mathematical synthesis). Mathematical analysis is the procedure to ***discover*** proof, and mathematical synthesis is the proof, i.e., the method to express, presents the discovered proofs. If our thinking process is hybrid, why not try to reach the reader by means of hybrid writing, instead of the frequently used highly linear and serially structured writing? This is efficient for the reader but we are not sure about its effectiveness, as the former generates more passive thinking from the reader than the latter. We have reasons to believe (with no justification but our own teaching

think that both perspectives are, at least epistemologically", polar opposites that even require each other in scientific evolution. Both perspectives address different issues nurturing each other, in the intellectual dimension. We may even suggest that they actually have, at least, implicitly, cybernetic relationships between them. This may follow a suggestion we will make below regarding the cybernetics relationships that exist between analysis and synthesis. We have empirical experiential regarding this relationships, at least, at least in the methodological dimension, in the context of a General Systems Methodology (Callaos N. , Metodología Sistémica de Sistemas [A Systemic Systems Methodology], 1995/2020), (Callaos N. , A Systemic 'Systems Methodology', 1992a)

experience) that hybrid writing may require more intellectual effort from the reader, but it may transmit not just information and knowledge but also generate a deeper understanding, especially because of the different contexts in which a notion might be inserted and, hence, repeated.

The way of expressing the ideas in this article will be a mixture of linear and non-linear thinking and reading. Its expositional macrostructure is or seems to be, a serial one, while parallel and non-linear thinking will be expressed via insertions, in order to add meaning to them, because of the context of the respective paragraph and/or section

2. Cybernetic Thinking and Doing Is Not New

> There is nothing new under the sun. *Ecclesiastes* 1:9

> "The end of the world: the wholesale *internal introversion upon itself* of the noosphere, which has simultaneously reached the uttermost limit of its complexity and its centrality... the overthrow of equilibrium, detaching the mind, fulfilled at last, from its material matrix, so that it will henceforth rest with all its weight on God-Omega... critical point simultaneously of *emergence and emersion*, of maturation and escape." Pierre Teilhard de Chardin (1881-*1955*), biologist, paleontologist, philosopher, and theologian. (1976/2008, pp. 287-8)

Cybernetics has**, tacitly**[6] or **implicitly**[7]**,** supported the thinking/doing of human beings (in order to address their ends and needs) since, at least, the first water clock, about 5000 years BC, according to some authors. We will also show a few examples where, implicitly and explicitly, it has been present in human beings thinking, since, at least, Socrates and Plato, who used the word explicitly to refer to self-control or self-governance[8] up to recent thinkers whose thoughts are supported, at least implicitly, by cybernetics. As a recent example, we may mention the geological and theological interpretation of universal evolution made by Pierre Teilhard de Chardin's Noosphere which would evolve to the Omega of the evolution that started at Alpha. This interpretation may be conceived as a cybernetic cosmic interpretation of evolution. Pierre Teilhard de Chardin's interpreted linear evolution as part of a larger non-linear process that starts with God and evolves to God.

We may also think that the entire Universe has a cybernetic nature. This thought may be supported by Steven Brewer, for example, when he refers 1)

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[6] We are using the word "tacit" in the sense of Polanyi's (1958/2015) "Personal Knowledge" i.e., roughly, generated by personal (subjective) experience. .

[7] Implicit knowledge is not explicit but with the potential to be made explicit.

[8] The term self-cybernetics may be more adequate in this case.

to the initial cells, formed in the primordial or prebiotic soup, and 2) to a Darwinist evolution perspective, in which each of the cell's "components, forms parts of a tightly regulated network of chemical processes allowing it to reproduce and survive in a whole range of environments. It's a matter of *control* over input, output, and processes… It's *like the thermostat* that shuts off the heating to keep the temperature regulated" (Brewer, 2013, p. 17) [Emphasis and Italics added]

Up to *chemical-based control*, there seems to be a consensus between Darwinists and those who have a teleological interpretation of Evolution. Where there seems to be differences is regarding *information-based control*. The reasoning from a teleological perspective of Evolution is as follows:

> *"What's obvious is that the more complex the living system, the more layers of control* and the more types of chemical *information* need monitoring… the evolution of information processing is as important as evolution of chemistry. Complexity in chemistry goes hand in hand with the intelligence needed to control this chemistry. *This control system is itself the primordial intelligent mind*… if these controls and information systems are built in the very mechanisms used by the cell to reproduce and survive and aren't imposed from outside, surely what we are talking about is a sort of *'embodied mind'*. (Brewer, 2013, pp. 17-18) [Emphasis and Italics added]

Consequently, both sides in the controversy, represented by the etiological and the teleological perspective of Evolution, agree regarding the control mechanisms that existed since the initial cells. What they seem to disagree with is the kind of control: just chemical or chemicals and informational. Both perspectives coincide in accepting that control was present in nature from the very beginning of Evolution. This means that control, i.e., cybernetic systems, is at the very base of Nature. So, are we here referring to a *pan-cybernetic world* and/or **pan-cybernetic Evolution**?

To answer this question, it may be highly supportive in our thinking to refer to Lonergan's *"scheme of recurrence"* as the basic notion that supports the construction of one of the most important, comprehensive, and integrative intellectual achievements of the XX Century. This notion, along with the notion of "emergent probability", also supported what is known as "an early model of complexity" (Bretz, n.d.) Both are being used in the construction of artificial complexities with emergent probabilities.

Michael Bretz summarized it in the following way:

> "Schemes of Recurrence are conjoined dynamic activities where, in simplest form, each element generates the next action, which in turn generates the next, until the last dynamic regenerates the first one again, locking the whole scheme into long term stable equilibrium. BL modeled generic growth as the successive appearance of conditioned Recurrent Schemes (RS), each of which comes into function with high probabilistically once all required prior schemes have become functional. RS's can be treated as dynamic black cells of activity which themselves may contain internal structures and dynamic schemes of arbitrary complexity. Emergent Probability is a generic heuristic model. Applications to specific physical problems require detailed knowledge of the recurrent schemes' makeup and of their interrelationships" (Bretz, n.d., p. 1)

Actually, Lonergan's conception of recurrent and productive complexity is being used as a heuristic for constructing artificial electronic networks for the generation of hierarchies of networks, which go from less to more complex instances. The more complex ones require the less complex, i.e., simple stable "schemes of recurrence" in order to exist, but the less simple ones do not depend on the more complex to exist. These kinds of computing heuristics are completely based on Lonergan's notions, conceptions, and intellectual works.

So the way Lonergan explained Natural Evolution is being used as a way, a heuristic, for constructing Artificial Complexities.

But, let us get back to our main topic in this section, with Lonergan's words. He affirms that[9]:

> "The notion of the scheme of recurrence arose when it was noted that diverging series of positive conditions for an event might coil around the *circle.* In that case, a series of events *A, B, C,…* would be so related that the fulfillment of the conditions of each would be the occurrence of the others.[10] Schematically, then, the scheme might be represented by the series of conditionals: If *A* occurs, *B* will occur; if

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[9] We are using a large Lonergan's text in order to avoid interpreting him, but except via footnotes.
[10] It is good to notice, here, that Lonergan is affirming that the parts depend on the *whole* to exist, and vice versa. Consequently, we might use analogical thinking to suggest that knowing oriented to the parts is required for a conceptions oriented to wholes, and vice versa, Then analytical thinking may be required for synthetical thinking and vice versa We will suggest that in section 6.

B occurs, C occurs; if *C* occurs…A will occur. Such a circular arrangement may involve a number of terms, the possibilities of alternative routes, and in general any degree of complexity.

Two instances of greater complexity may be noted. On the one hand, a scheme might consist of a set of almost *complete circular arrangement* of which none could function alone yet all would function if conjoined in an interdependent combination. On the other hand, schemes might be complemented by **defensive circles**, so that if some event *F* tended to upset the scheme, there would be such sequence of conditions as if *F* occurs, then *G* occurs; if *G* occurs then *H* occurs; if *H* occurs, then *F* is eliminated.[11]

In illustration of schemes of recurrence, the reader may think of the planetary system, of the circulation of water over the surface of the earth, of the nitrogen cycle familiar to biologists, of the routines of animal life, of the economic repetitive rhythms of production and exchange. In illustration of schemes with defensive circles, one may advert generalized equilibria. Just as a chain of reaction is a **cumulative** *series of change*[12] terminating in an explosive difference, so a generalized equilibrium is such a combination of defensive circles that any change within a limited range is offset by opposite changes that tend to restore the initial situation. Thus, health in a plant or animal is a generalized equilibrium[13]; again the balance of various forms of plants and animal life in an environment is a generalized equilibrium; again, the economic process is conceived by older economists as a generalized equilibrium." (Lonergan, Collected Works of Bernard Lonergan. Vol. 3 - Insight: A Study of Human Understanding, p. 141) [Emphasis, italics, and footnotes added]

So, is Evolution a combination of negative and positive feedback? Are cybernetic systems necessary for Evolution? Are they among one of its causes? May we say that cybernetic systems are both, efficient and telic causes of evolution? If yes, then this may be a way to synergistically relate the etiological and the teleological perspectives? Are both perspectives cybernetically related? Are both intellectual perspectives polar opposites?

If, for any reason, we do not accept the notion of a *pan-cybernetic Evolution*, let us explore if we can assert the notion of pan-cybernetic thinking and doing in human beings. If we can conclude that cybernetic processes support, implicitly and/or explicitly, human thinking and doing,

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[11] It is good to notice that, here, Lonergan is referring to negative feedback.

[12] It is good to notice that, here, Lonergan is referring to positive feedback

[13] Lonergan is referring here to Homeostasis, for which we will provide few and short details below and especially in section 4.1.

then *it would be evident the importance, even the necessity, of developing a Cybernetic Philosophy, or different Systems of Cybernetic Philosophy*.

Let take an example that would show cybernetic thinking for describing or explaining biological phenomena. It is consensually accepted that one of the characteristics of living organisms is *homeostasis*[14]. So, if cybernetic is not con-natural to all biosphere, is it, at least, con-natural to, all organisms, or at least, to corresponding thinking processes about the nature of this phenomena?

Let us reiterate that the main purpose of this section, as well as of the immediately following one, is to support the idea that "Cybernetic" thinking and doing are nothing new. "Cybernetics" has always existed, in parallel with all known human history. As a notion, it was used to explain other notions or concepts. As an implicit cognition has been present in what we may call ancient engineering. In the latter case, it was an implicit one before engineering and as an explicit concept, notion, career, and profession, later. To notice that would support our suggestion that "cybernetics", is consubstantial and con-essential with human nature. Regarding the Natural World, opinions are a kind of divided between *teleological explanations* and *teleonomical descriptions*.

Teleonomy *describes* "*apparent* purposefulness and goal-directedness" in organisms and computer programs. In our opinion, teleonomy has created an increasing number of confusions, between descriptions of *apparent and real purposefulness and of goal-directedness*. A hyperbolic example may be given with the feedback mechanism in "toilet tanks", which may be characterized as a teleonomic mechanism, i.e., it operates according to laws ('*nomos*') that make it show an *apparent purpose and goal-directedness.* It does not make any sense to say or conceive that "toilet tanks" have purposes; let alone the same purpose to all of them. It is the purpose of a human who found a way to achieve it by means of a mechanism that models human thinking oriented to achieve a purpose. "Toilet tanks" are teleonomical mechanisms created to support human teleology. They represent the teleological nature of human beings and are based on hydro-mechanical laws that make them show an *apparent purposeful action*. Does that apply to Artificial Intelligence as well? Does it apply to other electrical or mechatronic systems which behavior is *described* by means of *apparent purpose* that *model* (electronically or electro-mechanically) human thinking and, hence, purposes? We will provide a few details regarding this issue in the following section.

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[14] In the next section, we will return to the notion of *homeostasis*, but in another context.

To the question: Are organic homeostases teleological or teleonomic phenomena? The suggested answer is both:

1) It is teleonomic if it is being *described* by a biologist in an etiological context, i.e., explaining a biological phenomenon by means of their efficient causes, which precedes their related phenomena; which in turn is based on backward thinking

2) It is teleological if it is *explained* by means of forward-thinking, i.e., using the notion of "telos". This kind of explanation may be found even from an etiological perspective, especially those that combine backward and forward selection processes to explain the survival of a biological treat or function. Regarding an explanation in this context, let us here (in order to be brief) provide the reader with the following text, which is the last paragraph used by Karen Neander to close her reference article and, hence, her conclusion:

> "Although Beckner and Cummins[15] were correct about functions having other theoretical roles in biology, they were wrong in thinking that teleology in biology must be a scientific scandal in post-Creationist times. The biological notion of 'a function' is a genuinely teleological notion. Teleological explanations do not play a significant role, as such, in evolutionary theory, and they certainly do not substitute for evolutionary explanations of the origins or persistence of traits. However, if my claims in this paper are correct, teleological explanations based on biological function are a perfectly respectable form of elliptical causal explanation. According to the etiological theory I defend, talk of functions involves forward-reference to the effects that items or traits are supposed to have, and also an implicit backward- reference to a causally explanatory selection process, during which those items or traits were selected for those effects which are their functions. This parallels other teleological explanations that are apparently less problematic. The etiological theory can therefore explain some otherwise anomalous facts about our attitude to explanations that purport to be teleological, although they appeal to biological function. They are genuinely teleological if this theory is correct." (Neander, 1991, pp. 457-8)

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[15] Beckner and Cummins are two authors who are against any teleological explanation in Biology. Each one of them used extraordinary and not very scientific, even offensive and insulting, words in their verbal fight against any author that allow teleological explanation in Biology.

A teleological explanation in an etiological context (which is accepted by orthodox scientific perspective in Biology) shows that a teleological explanation of "homeostasis" is not, anymore, "a scientific scandal in post-Creationist times" as was phrased, above, by Beckner and Cummins, and reported by (Neander, 1991, pp. 457-8)

Meanwhile, let us point out that the combination of 1) the huge diversity of purposes and needs of human beings, and 2) their connatural cybernetic thinking/doing have been the source of the diversification in both a) the historical *roots* of Cybernetics, as well in b) the contemporaneous *branches* of cybernetic knowledge fields and applications. This would explain:

1) Its multi-disciplinary nature and its application in so many different disciplinary, inter-disciplinary, and trans-disciplinary fields, and, hence,
2) why Cybernetics and the System Approach require and generate inter-disciplinary communication, even between Science and Art, as well as between Science and Theology. It would be evident to suggest that this intra-, inter-, and trans-disciplinary nature of Cybernetics is what generated so many different definitions[iii] of Cybernetics. We may, probably, be able to write a whole article enumerating these definitions and describing the notions involved with them. It would even require a book of several volumes to interpret each of these definitions according to the context in which each author used them. In this article, we will not even enumerate the definitions of the most known authors.[16] We will restrict ourselves, here, to the purpose of this article as well as to its spatiotemporal constraints. As we will reiterate later, Cybernetics is not a concept but a notion[17], containing an increasing number of concepts and intersecting other notions, such as information. Frequently it has been and still is an implicit way of thinking, of cognizing. As a notion, it has to be *described. We can* define it in the sense in which it would be used in a given article, book, treatise, or a knowledge field, in order to

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[16] The definitions of some of the most known authors can be found on the web site of the American Society for Cybernetics , in the web page (Defining Cybernetics) at
https://asccybernetics.org/foundations/definitions.htm

[17] Elsewhere (Callaos N. , The Notion of 'Notion', 2013), we explained and described with details "The notion of Notion". Let us here resume it as follows: A "notion" is a set of related, or relatable, concepts and/or definitions. This set may be a fuzzy set. As such, a notion is described, not defined. It is based on definitions along with the relationships and potential intersections among them. The identified commonalities would generate a set of *connotations* while the different definitions would be the *denotations* of the associate notion. We will not try, here, to describe the notion of cybernetics, because it is not the central purpose in writing this article. But, we do need to stress the fact that Cybernetics is not a concept, though a related set of concepts. The best evidence of that is the never ending proliferation of its definitions.

avoid confusing the reader with other senses of the word, another meaning that may have in another knowledge field.

A comprehensive understanding of cybernetics, not limited to a discipline or a knowledge field or specific professional practice, requires cybernetic thinking, i.e., reflexive thinking and consecutive re-understandings via feedback loops. It requires analysis and synthesis feed-backing each other, bottom-up and top-down cognitions reinforcing each other via cybernetic loops.

These kinds of evolutionary processes also characterize cybernetic collective thinking of human beings, as species, initially in implicit[18] and/or tacit[19] knowledge, then explicitly, via explicit and shared knowledge. We will also try to show that Cybernetics is both: thinking and doing processes, also feed-backing each other, via implicit action-learning and action design. As implicit knowledge became explicit knowledge then action-research processes were triggered. All of this generated exponentially increasing levels of complexities and, hence, more *emergent properties* have been appearing. This evolutionary process of Cybernetics (supported and being supported by systemics) is analogous (or at least metaphorically similar) to the General Evolution, which also had emergent properties because of processes and systems with increasing levels of complexity. This is why Cybernetics is inherently related to evolutionary and co-evolving processes along with the properties of complex systems as, for example, emergent properties, "the whole is more than the sum of its parts"[20 iv,v], teleology, etc. All of these characteristics are also present in several interpretations of the General Evolution, as it might be the case of the paleontologist, biologist, philosopher, and theologian Pierre Teilhard de Chardin (1881-1955), biologist, paleontologist, philosopher, and theologian, quoted above. (1976/2008, pp. 287-8).

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[18] Knowledge that is not explicit but could be made explicit as, for example, Chomsky's *generative grammar* which is implicitly learned and known by human beings before having an explicit knowledge of grammar. (Chomsky, 1965)

[19] As we said, in footnote above, we are using "tacit" in Polanyi's sense (Personal Knowledge: Towards a Post-Critical Philosophy, 1958/2015) (The Tacit Dimension, 1966/2009), i.e. what we know but we cannot exteriorize or make of it an explicit knowledge. Polanyi compress it in this famous phrase, *"you know more than what you can tell"* (1966/2009) [Emphasis and italics added]

[20] Evidently, the word "sum" is not being used in its sense of "the result of adding numbers" (Merriam-Webster.com). In this sense, the whole is not more and not less than the sum of the summed numbers. So, we are using this phrase, as frequently was used, as an expressive metaphor, to refer to synergy, emergent property, Gestalt, etc. This phrase has been attributed to Aristotle and/or to Kurt Koffka (1886-1941), the German psychologist and founder of the Gestalt psychology. In both cases, the attribution is not correct. See end note iv, for more details regarding this issue.

The above quote of Father Pierre Teilhard de Chardin (1881-1955*)*, includes, in few words, the three most important notions of Cybernetics: 1) *feedback*, 2) *teleology*, and 3) *emergent properties*; which characterizes complex systems and it is one of the pillars of General System Theory and System Philosophy, where systems, as wholes, are larger than the sum of their parts. (This has already been stressed by Aristotle, Scholastics and Medieval Arab, Persian, Jewish, etc. philosophers, among many others.) So, now, Systemics and Cybernetics are rediscovering what has been known since, at least, Aristotle and has been known for about 2000 years.

Furthermore, Jesus Christ described himself as the "Alpha and Omega, the Beginning and the End". Indian religions believed and still believe in re-incarnation, which is emerging in the west in public opinion, reincarnation therapy, education, etc[vi]. Consequently, it is evident that cybernetic thinking has been implicit in human thinking for a long time, and still is present in many spiritual perspectives. For example, the expressions of the Nicene Creed like "Light from Light", "God from God", "True God from True God" are different ways of expressing the result of implicit feedback processes, hence implicit cybernetic thinking or processes.

Noreen Herzfeld (Cybernetics and Religion, 2021), asserts, in the Oxford Research Encyclopedias that "a cybernetic view of the development of religion focuses on religion as an adaptive mechanism for the survival of groups as they evolve and change in an atmosphere of physical and social competition." How about focusing, not on the development of religion, but on the development of the spirituality and/or intellect of the religious people? This perspective does not contradict Noreen Herzfeld's perspective, but it may even reinforce it. May we not think that religious people also have cybernetic thinking and, hence, they try to adapt to their environments not just by means of physical mechanisms, but also by means of spiritual means? If we accept this possibility, then religions provide more evidence of the con-essential cybernetic thinking of human beings. Why should we limit ourselves to the material domain of human beings? Why we cannot think, cybernetically, that matter and spirit are cybernetically related via negative and positive feedback as well as feed-forward and hence the material and the spiritual dimensions of human beings co-evolve, by means of generating and being supported by material-spiritual synergies. Can we not conceive matter and spirit as polar opposites; which, as such, require and nurture each other in the context of the noosphere or in the human sphere? Do matter and spirit have co-regulatory and co-additive cybernetic loops? Do they co-evolve similarly to how they, as a whole, also co-evolve with their natural, artificial, social, and internal (bio-noetic) environments?

Should not questions like the above ones be addressed by philosophical thinking? Should this cybernetic human thinking and doing be addressed by Philosophy? To address the intellectual importance and even the pragmatic usefulness of a Philosophy of Cybernetics and the support that might be provided Systems Philosophy is another main purpose of this article.

On the other hand, Teleology, complex systems, and wholes (that are larger than the sum of its parts) are the main notions in General Systems Theory and in Systems Philosophy. These notions characterize systems and as *genus*, hence they can also be predicated for cybernetic systems, which are *species* characterized by their internal feedback, via closed loops. Open-loop control requires an external agent to provide the required feedback, in order to control the system. Open-loop control systems feed an external agent in order to complete the feedback loop. Feedback systems should include their own feedback. So, open-loop control is part of the respective cybernetic system. The supra-system (open-loop control and its external feedback) is the cybernetic system. Isolated open-loop control is not a feedback system but it is part of a potential cybernetic system, i.e., it provides support (to a usually a human being) so s/he would be able to input the required feedback.

Now, we need to refer to platitudes and much known historical facts in order to provide conceptual and notional support for achieving or, at least, for approaching our objective in this article.

It is a platitude to write, as we did above, that "Cybernetic Systems" are species in the genus "systems". Indeed, Kenneth Boulding (General Systems Theory: The Skeleton of Science, Apr. 1956)[21] presented a hierarchical typology of "systems" where, he named "Cybernetic Systems" its third level of systems[22], and associated it to *control* systems. It is well known in Predicate Logic, that what we can predicate regarding the genus, i.e., from Systems Philosophy can also, correctly, be predicated for the species of "Cybernetic Systems", hence, for "cybernetics".

This is evident in predicate logic, but we felt the need to repeat it because of the frequency with which we have noticed that some scholars predicate in the opposite direction. For example, it is frequent to read authors attributing to the "Scientific Method"[vii], characteristics, and features that are found just

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[21] This article was republished in General Systems, Yearbook of the Society for General Systems Research, vol. 1, 1956.

[22] Boulding (Boulding, Apr. 1956) also associated Cybernetic Systems to **Control (feedback) Systems** and used the thermostat, as a known and very simple example.

in experimental empirical science[23]. Because of this reiterated fact, we preferred to start with the platitude mentioned above. It is even more perplexing to notice that sometimes "intellectual rigor" is reduced to "scientific rigor" or, which is worst, to judge the rigor of an article in a scientific discipline, from the perspective of another discipline or to judge engineering or design article according to the rigor expected in the scientific discipline of a reviewer. It is not easy to imagine the frequency with which these judgments are being made in articles review. (Callaos N. , The Notion of Intellectual Rigor, 2020)

In the next section, we will briefly provide a few historical facts[24], as a means for:

1) Supporting the reasoning that we started making above, regarding the con-essentiality of cybernetics in human thinking/doing, i.e., in the context of the noosphere,
2) Identifying some conceptual, notional, and logical consequences; which (up to our knowledge) are not mentioned with the frequency that its importance requires. We need to make explicit this kind of conclusion because it is among the conceptual bases of this article. Another intention of briefly mentioning some selected historical facts is also to provide the reader with some input in order to show that Cybernetics is not a new, as concept, notion, idea, or generator of practical instruments. What is new is the set of technologies with which, lately, cybernetic systems are being achieved. We will try to show, as we quoted at the beginning of this section, that *"There is nothing new under the sun."* (*Ecclesiastes* 1:9), at least, regarding cybernetic thinking or doing.
3) Providing more details related to the Intellectual Importance and Pragmatic Usefulness of a Philosophy of Cybernetics

3. A Telic Selection of Few Historical Facts

"History is the self-knowledge of humanity." Ortega y Gasset.[25]

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[23] Some details regarding this issue were included in (Callaos N. , The Notion of Intellectual Rigor, 2020).

[24] Detailed historical information may be found easily on the web and in many articles. Our intention in this article is to provide the minimum required context to a main purpose of this article, which is to insert Cybernetic in the context of the systems approach, thinking and theory and, consequently, to insert Cybernetic Philosophy in its genus which is Systems Philosophy.

[25] Quoted and referenced by Patrick Brown (System and History in Lonergan's Early Manuscripts, 2001), p. 33.

As we anticipated above, we will initiate in this section, the presentation of some selected historical facts, in order to interpret them in their historical contexts and perspective. Important cybernetic notions are not new and the oldest they are, the more important is a philosophy that includes them. Among these notions, we have, for example, *first and second-order cybernetics*, self-control, implicit or tacit cybernetic thinking/doing, relationships between cybernetics and evolutionary processes, including natural and methodological ones, etc. We think that, sometimes, historical contexts are more adequate for capturing and providing meanings than conceptual definitions or a-historical descriptions. This is especially correct in the case of Cybernetics because its roots are mostly based on implicit or tacit knowledge.

We will show that Cybernetic thinking/doing has been tacit knowledge for a long time (at least 5000 years BC). Then some of it was transformed into implicit knowledge, while some of its aspects or applications were transformed into explicit knowledge. As we noted above, the word "Cybernetics" was used by Socrates and Plato, about 400 BC, with the same meaning of control. As we will see, that differences of meaning are basically related to *what* is being controlled, by *whom* or by *what*, and *for* what. The latter is the most controversial one because of disputes between reductionist and holistic perspectives as well as between etiological and teleological notions. We will suggest conceiving both kinds of perspectives and notions as polar opposites and not as contradictory ones. This might be the result of accepting that "analysis" and "synthesis" are or, at least, may be cybernetically related, as we will propose below, along with other cybernetic relationships that we will also propose.

The selection of the historical facts that we will start making here is an intentionally teleological one. It is made according to the 'telos' of writing this article. We will interpret and comment on each of the selected historical facts, with the purpose of showing the intellectual and the pragmatic importance of fostering studies related to Philosophy of Cybernetics. Some of our interpretations will be accompanied by questions because they require more reflections from the writer and/or from the potential readers of this article. Having provided this contest let us know to start with some historical facts intentionally and purposefully selected, among many others that would require several books to describe all of them and even more books to interpret all of them.

It is well known, that the etymological meaning of "Cybernetics" derives from the "Greek kybernetes "steersman" (metaphorically "guide,

governor"), from kybernan "to steer or pilot a ship, direct as a pilot," figuratively "to guide, govern,"… The construction is perhaps based on 1830s French cybernétique "the art of governing." (Online Etymological Dictionary)

In the context of Greek Philosophy, Kevin Kelly asserts that "Plato attributes Socrates as saying, 'Cybernetics saves the souls, bodies, and material possessions from the gravest dangers'." (Kelly, 2009, p. 105). Notice that:

1. As Kelly affirms, this statement "encompasses both shades of the word. Government (and that meant self-government to [the] Greeks) brought order by fending off chaos. Also, one had to actively steer to avoid sinking the ship." (Kelly, 2009, p. 105)

2. It refers to individual self-control or self-governance, oriented to a more productive and less painful life. Is this some kind of second-order cybernetics? Is it not self-observing, hence observing the systems that relate observer and the observed? Is it not reflecting on our own emotions in order to take some stabilizing action on ourselves'? Is that just reflection or, also, reflexion, (i.e., reflexive thought, thought turned back upon itself, including meta-reflection)? Is it not the cybernetics of the "self" as Gregory Bateson conceived it in his work (The Cybernetics of 'Self': A Theory of Alcoholism, 1971)?

Should not we explore the philosophical, ethical, intellectual, and pragmatic values of this initial conception and meaning of the term of Cybernetics?

This initial use of the term "cybernetics", by Plato and Socrates, is strongly associated with the Stoic Philosophy, especially with regards to ethical thinking and acting, as well as to methodologies of forming habits oriented to individual and societal well-being. This has, evidently, a *pragmatic* value in the context of emotional and spiritual robustness, which may generate an intellectually *productive* life. Seneca's Stoicism, for example, has been associated with the notion of "Philosophy as a Practice" in "*The Stanford Encyclopedia of Philosophy*" (Vogt, 2020). Could Cybernetics philosophy be conceived in the context of "Philosophy as a Practice" in its material and spiritual dimensions? May we think about relating the latter to some kind of *self-cybernetics*?[26][viii] May self-cybernetics be thought of as Second-Order

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[26] There have been several approaches, from different perspectives of the notion of self-Cybernetics, M. Joseph Sirgy (Self-cybernetics: Toward an integrated model of self-concept processes, 1990), for example, describes ¨self-cybernetic system … as a cyclical process involving monitor, input, comparator, and output processes. The monitor component is described in terms of

Cybernetics? If so, is the second-order related to the human being or to a supporting external system? M. Joseph Sirgy (Self-cybernetics: Toward an integrated model of self-concept processes, 1990) relates self-cybernetics to self-concept[27]. But, from another perspective, *we may also associate self-cybernetics with self-notion, self-cognition, and, hence, self-control*. In this context, it becomes evident that Stoic Philosophy is a human-centered philosophy of self-cybernetics. This is what Plato and Socrates named cybernetics. *Could Stoicism be conceived as a form of Second Order Cybernetics?* From some perspectives, it may be conceived as an application, to the emotional and spiritual human domain. It would be similar to observing the observer/observed system, i.e., in this specific case, it would be observing the system that related human beings to their own environment. In other words, it would be the habit of **reflexive practice** regarding what is related to our thinking, feeling, conceiving, and perceiving from our environment; which is what produces our thinking, feeling, conceiving, and perceiving.

This perspective may make sense, but from our conceptual perspective, Stoic self-control and self-cybernetics should not be identified with Second-Order Cybernetics. The latter is based on the Copenhagen interpretation of Quantum Mechanics as to the observer affecting what is being observed. Consequently, the observer should also observe the observing system, including her/himself. We suggest that this is a kind of **meta-observation, which includes self-observation. This notion is not the same as self-control.** Of course, there is feedback, but this does not make them the same and it might be confusing to use the same words for it. A similar suggestion may be made with regards to the notion of **auto-poiesis**. This term means, etymologically, self-production and Maturana associated it with life, as a distinguishing characteristic and feature of life. Then, Niklas Luhman, who is a Systems Theorist and a prolific writer[28], made several analogies with Maturana's notion of auto-poiesis. This is, in our opinion, great as a source of intellectual creativity. But, analogical thinking is usually an input into logical thinking. Otherwise, it suggests possibilities and it may potentially be a source of other analogies. But, is this justified belief? Is it knowledge? Is it episteme or doxa? Is it an essay supported by analogies based on

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self-monitoring; input component is described in terms of self-perception; comparator component is described in terms of self-evaluation; and the output of the self-cybernetic system is described in terms of three psychological processes—behavior change, cognitive change, and information search." (Sirgy, 1990, Abstract). The complete abstract has been included in the end note i.

[27] Thomas Marlowe, opportunely, commented that "One could argue that self-concept is precisely the target by which corrective actions are determined and results are measured, circling back to [the] concept of "self-notion, self-cognition, and self-control"."

[28] Niklas Luhman wrote about 500 scholarly articles and 70 books in diverse fields, such as "law, economy, politics, art, religion, ecology, mass media, and love."(Wikipedia)

consensually accepted scientific notions? Essays may be even better than research because they may stimulate scientific creativity and philosophical interest in many intellectual fields. But the problem with Luhman's analogies is that they have been found not to be are not valid, according to the same Maturana, who coined the term, auto-poiesis and used it to make a great differentiation between what life is and what it is not. *Analogical thinking is completely necessary* for intellectual, not just scientific, advancement; but, in many fields, it is not *sufficient*, because it needs to be scrutinized by the logic(s) of the respective knowledge field. On the other hand, auto-poiesis was defined as its etymological meaning but applied to transmit the notion of "self-producing systems" as what differentiates and characterizes life. Several respectable scholars used the same term in order to refer to "self-communication" (as is the case of Luhman). Why do they not use auto-epikoinonía instead of auto-poiesis?

Alexander Riegler makes the following important affirmation regarding Second Oder Cybernetics.

> *"Stuart Umpleby*, having worked at the BCL [Biological Computer Laboratory) at the University of Illinois] himself, deals with the paradigm shift from the observed to the observing system in von Foerster's second-order cybernetics. His paper describes some of the author's personal experiences concerning different styles of thinking in continental Europe and the US/UK. In light of these experiences, Umpleby proposes to make one further step in the Foersterian philosophy of science: from the observing system to the cultural context of the interaction between observed and observing system."

Following the direction taken by Umpleby, and taking into account that the academic world is a set of academic cultures, and even tribes, as Becher & Trowler, (Academic Tribes and Territories: Intellectual enquiry and the culture of disciplines , 2001), concluded, after a detailed analysis, then we may apply Umpleby's suggestion to academic fields in the following terms: "to make one further step in Foersterian philosophy of science: from the observing system to the *academic cultural* contexts of the interaction between observed and observing system." If we do that, then we have a Second-Order Cybernetic (SOC) explanation of the diversity of academic interpretations regarding what is SOC and how and where it might be applied, and what phenomena may be called Second-Order Cybernetic phenomena. *We should move from the observing academic to the interaction between observed and observing system.*

Another alternative to minimize, or at least, decrease this kind of unintentional confusion created in the academic world because of the huge number of fields that have been supporting the trans-disciplinary field of Cybernetics, is by means of Philosophy of Cybernetics. There is a high probability of having different philosophical systems, but in each one of the concepts, notions, and terms being used would be less ambiguous with less potential meaning and the context (of the respective philosophical system) would generate less equivocalness of the sense in which a term is being used.

Getting back to the notion of First Order Cybernetics (which also has had so many different definitions) people have been 1) *implicitly doing it*, for almost 4000 years, and 2) *explicitly* thinking cybernetically and even using the term cybernetics, since at least, Plato and Socrates. Below, we will continue providing the 'telic' selection we are making, in order to support what we just wrote (which will be reiterated in different contexts).

Prior to modern times, water served as the power source for the ancient open and closed (feedback) control systems. With regards to this issue, Lisa Ferguson affirmed that "Ancient control systems used water almost exclusively as their method of control, mainly because of its availability and its versatility of states. From the rapid flow of a river to the rising power of hot steam to the slow drip of water from a bucket, water was the harness of the natural world for control engineers. Without easy access to water, many of the control systems of the ancient world would not exist." (Ferguson, 2015, p. i). This explains why the most ancient control systems were based on water, though fire and air were also served as source of power or energy. The most ancient (about 1500 years B.C.)[29], water clocks were based on open-loop (non-internal-feedback) and closed loops (internal feedback) control systems. The most ancient *water-based clock* is Ctesibius' *clepsydra*[30]. (270 BC). As far as it is known, Ctesibius designed and implemented the first *self-regulatory* (i.e., internal feedback), closed-loop, the system that required no external intervention for its control.[31]

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[29] Some authors as, for example, *Harrison J. Cowan, (* (Time and Its Measurement: From the stone age to the nuclear age, 1958), referenced by http://www.self.gutenberg.org/articles/eng/water_clock

[30] "[F]rom Latinized form of Greek klepsydra, from stem of kleptein "to steal, to hide" (see kleptomania) + hydor "water" (Online Etymological Dictionary)

[31] These water-based feedback systems are still being used in toilet tanks.

We may also mention many other ancient technologies based on control systems, as, for example, the water wheel (4000 BCE)[32] and Heron's Aeolipile, also known as the first steam engine.

Many more ancient control systems may be cited, including internal feedback-based control systems. A relatively large sample is found in the first chapter ("A Brief History of Feedback Control") of the first part ("Introduction to Modern Control Theory") of Frank L. Lewis' book (Applied Optimal Control and Estimation: Digital Design and Implementation, 1992).

Our intention here is to support our perspective with regards to 1) cybernetic systems are very ancient instruments and technologies and 2) the use of the term "cybernetics" is as old as Plato's and Socrates' philosophy. In the latter case, its, implicit or explicit, meaning, of "self-control" has been recurrent through different philosophical systems, especially in Stoic philosophical systems. There is a re-emergence of what has been called "Modern Stoicism", which also includes pragmatic applications basically, but not uniquely, in:

- Management, e.g., Bowden's (The Ethics of Management: A Stoic Perspective, 2012)
- The military, e.g., Nancy Sherman's (Stoic Warriors: The Ancient Philosophy behind the Military Mind Illustrated Edition, 2007)
- Psychology, e.g., D. Robertson and T. Codd's (Stoic Philosophy as a Cognitive-Behavioral Therapy, 2019)

So, how important and/or useful would be to extend and relate to the notion of self-cybernetics in some kind of *supporting systems* for self-concept, self-notion, self-cognition, and self-consciousness processes in human beings? Notice that we are referring to *supporting systems, not to systems of artificial consciousness. The support may be human-made, not to be confused with artificial consciousness.* The latter is a controversial issue. It strongly depends on what we understand by consciousness and, consequently, if it is limited to human beings or its meaning can be extended to machines, servo-mechanisms, mechatronic systems, robots, etc. Moving words from one context to another brings to the mind Ludwig Wittgenstein's language games, which is typical in some politicians and marketers. If we do that, we should refer to the meaning or the sense with which the word is being used, in order to avoid confusion and

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[32] Mary Bellis asserts that "The first reference to a water wheel dates back to around **4000 BCE**." (The History of the Water Wheel, 2020) [Emphasis and italics added]

misinterpretations which generate a waste of intellectual effort and emotional energy.

4. Roots of Tacit, Implicit, and Explicit Cybernetic Notions

After the meaning with which Plato and Socrates used the term "cybernetics", André-Marie Ampère[33] used the term "Cibernétiques", to mean the "Science of Civil Government". (Tsien, 1954, Engineering Cybernetics, preface vii). But, as Tsien affirms, wars accelerated the technological development of the "science of control and guidance of mechanical and electrical systems. It is, thus, perhaps *ironical* that Ampère's word should be borrowed by Norbert Wiener to name this new science so important to modern warfare." (Tsien, 1954, preface vii), [Emphasis and italics added].

Some people still have the hope and the expectation that cybernetics may support moving to better or more adequate civil governments. It could be thought that the philosophy of cybernetics may help in this objective, at least, as a supporting system for self-education of politicians that may have (philosophically, ethically, and theoretically) conceived "politics" as civil service and not as a career for power accumulation. In this sense, cybernetics may support ethically educated politicians, who try to gain power in order to use this power as civil service. This may seem like a romantic and unfeasible purpose. If this is the case, we can, at least, try to conceive this objective as a utopia, which function is not to be achieved but to orient our decisions making in the area of education, in general, and specifically in ethical education. Is it also a utopia what was just written here? It might be, with high probability, but what is wrong with utopias as long as we use our analogical thinking and know that a compass is not usually used to go to the North Pole, but to get oriented in our decisions, related to our journey?

4.1. Homeostasis

Homeostasis is a good example to present the usual controversy between reductionists and holists, teleonomy and teleology, etiology and teleology. For some biologists, it is evident that the only way to explain homeostasis is by means of the notion of 'telos', while others insist on explaining it via chemical factories with internal autocatalytic chemical processes. No matter if homeostasis is explained via chemical or informational feedback, it is a

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[33] (ampère, 1843/2010), referenced by (Tsien, 1954, p. preface vii).

good example 1) of well discussed cybernetic phenomena before Wiener's cybernetics and 2) for supporting our pan-cybernetic thesis.

1. Claude Bernard's (founder of Modern Physiology) notion "*milieu intérieur*," (internal environment) in 1878[34]; is where he asserted its constancy, which, later, was named homeostasis by Walter Bradford Cannon (1871 –1945).

   Claude Bernard asserted that "The fixity of the milieu supposes a perfection of the organism such that the external variations are at each instant compensated for and equilibrated... All of the vital mechanisms, however, varied they may be, always have one ***goal***, to maintain the uniformity of the conditions of life in the internal environment... The stability of the internal environment is the condition for the free and independent life (Bernard, 1974 [1878])[35] [Emphasis and italics added]. Notice that Claude Bernard uses the notion of "goal". So, his perspective is a teleological one.[36]

2. It is asserted in the (World Heritage Encyclopedia) that Walter Bradford Cannon "popularized the concept of homeostasis from the earlier idea of Claude Bernard of 'milieu interieur', and popularized it in his book *The Wisdom of the Body*, 1932. Cannon presented four tentative propositions to describe the general features of homeostasis:

   1. ***Constancy*** in an open system, such as our bodies represent, requires ***mechanisms that act to maintain this constancy***….
   2. Steady-state conditions require that ***any tendency toward change automatically meets with factors that resist change***….
   3. The ***regulating*** system that determines the homeostatic state consists of a number of cooperating mechanisms acting simultaneously or successively….
   4. Homeostasis does not occur by chance, but is the result of ***organized self-government***." (World Heritage Encyclopedia) [Emphasis and italics added]

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[34] Several years after Charles Darwin's "On the Origin of Species" in 1859

[35] Referenced and quoted by (Gross, 1998, p. 383)

[36] Thomas Marlowe appropriately reinforces Barnard making us notice "that the average healthy temperature in humans seems to have decreased from about 37 C to about 36 C, due to a lower rate of endemic infection and immune reaction, and perhaps better diet. So, there are environmental factors other than (and probably quicker than) evolution that have effects on the target state.

George E. Billman, a physiologist, recently affirmed, in an important article (Homeostasis: The Underappreciated and Far Too Often Ignored Central Organizing Principle of Physiology, 2020) that:

> "Homeostasis has become the central unifying concept of physiology and is defined as a *self-regulating process* by which an organism can maintain internal stability while adjusting to changing external conditions. Homeostasis is not static and unvarying; it is a dynamic process that can change internal conditions as required to survive external challenges. It is also important to note that *homeostatic regulation is not merely the product of a single negative feedback cycle but reflects the complex interaction of **multiple feedback systems** that can be modified by **higher control centers***. This hierarchical control and ***feedback redundancy*** result in a finer level of control and greater flexibility that enables the organism to adapt to changing environmental conditions. The health and vitality of the organism can be said to be the end result of homeostatic regulation. An understanding of normal physiology is not possible without an appreciation of this concept. Conversely, it follows that disruption of homeostatic mechanisms is what leads to disease, and effective therapy must be directed toward re-establishing these homeostatic conditions." (Billman, 2020, p. 1) [Emphasis and italics added]

4.2. Cybernetics and Biology

Homeostasis is one of the many examples of the role of cybernetic notions in explaining biological phenomena. It is evident that *the concept or the notion of feedback was already present in biology since, at least, 1878,* i.e., Bernard's 'milieu interieur', and up to recently, it has been underappreciated and far too often ignored central organizing principle, as was pointed out by Billman in the same title of his 1220 article (Homeostasis: The Underappreciated and Far Too Often Ignored Central Organizing Principle of Physiology, 2020). This means that cyberentic principles in Biology have been explicitly present in Biology since 1878, but "underappreciated and far too often ignored". The immediate question that comes to mind is: why? The answer may be evident, but certainly a cotroversial one. Many biologists insist that animals and human beings are machines, chemical processors and when they process information, they do it as computers, mehatronic systems, or robots. Consequently, *is it not time for philosophical studies on Cybernetics*?

Initial steps have already been made in Biology, oriented to a more comprehensive understanding of Biological Cybernetics, which necessarily requires the inclusion of the notion of telos, purpose, objective, goal[37]. These initial steps, in Biology, in this direction, started in 1932, when Bernard's 'milieu interieur' was renamed and popularized by Walter Bradford Cannon, with the name of Homeostasis, where he emphasized Bernard's "constancy" and *"goal"* oriented phenomena. Since then, we find in Biology (with an increasing frequency) the notions of 1) feedback control, i.e., internal regulative feedback loops and 2) goal, which may be considered the origin or, at least, among the origins, of the *re-emergence of the notion of teleology.* As we have mentioned above, not all biologists accept the notion of *goal,* but even those who do not accept this notion accept the notion of chemical feedback, not goal-oriented but as an evolutionary legacy. So, it is not surprising the influence that the biologist and philosopher Ludwig von Bertalanffy had in the Systems Movement, and the intellectual impact on the discipline of Biology. Many biologists were oriented to reducing biological systems to chemical factories or servomechanisms. But, with Ludwig von Bertalanffy, this situation started to change.

4.3. Synergies between reductionism and holist-teleological explanations?

We may think that reductionist perspectives may synergistically complement teleological perspectives, but this is not going to be achieved in the context of the struggle between anti-holisms and anti-reductionisms. A comprehensive philosophy of cybernetics is needed. Applying Systems Philosophy is, potentially, an adequate starting point, because it is logical to conceive and to accept that cybernetic systems philosophy is a species of general systems philosophy. This kind of initial step may help Cybernetic Philosophy in avoiding the nightmare being lived in the sterile confrontation

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[37] Thomas Marlowe adds a very important comment, on this issue. He called his comment "weak answer" but I am certain to qualify it as a fertile suggestion because it allows other orientation for reflections and, hence, for making the right question, which, according to Lonergan, are a necessary condition for understanding our experience. Marlowe suggests, regarding telos in Evolution, that "the current environment, which includes both the species' current state and that of the other species in therein, creates a multi-goal fitness function, and that optimizing that function—which itself changes—is the goal. This of course ignores both inception (the same rules clearly don't apply) and catastrophe (the goal is changing too rapidly or too radically for evolutionary progress to keep up, and it's all up to luck). But to some extent, the same can be said even for fully telic processes—their initialization does not follow the same rules as their deployment, and many clearly FOC [First Order Cybernetics] and SOC [Second Order Cybernetics] systems will fail in unpredicted (and especially unpredictable) circumstances, or in very-low-probability cases that were not designed into the system.

between reductionisms with holism. Both perspectives may be taken as polar opposites, at least form an epistemological perspective. As polar opposite, they may require each other instead of generating contradictions. As polar opposite, they may have co-regulative and co-amplificatory effects based on negative and positive feedback respectively. If this idea makes any sense, then we may have a *Dialectic Whole* formed by holistic and reductionist perspectives, as well as between teleological and etiological perspectives. This may probably be one of the fruitful applications of Cybernetic Philosophy, in the intellectual domain, i.e., to transform sterile controversies based on contradictions into synergic relationships based on polar opposites. If this transformation is possible, then Cybernetic Philosophy may generate more efficiency and effectiveness in the intellectual domain of Biology and Evolution. The latter might be biological, epistemological, and/or methodological evolution.

4.4. Cybernetics and Evolution

Getting back to historical facts, all the above, including cybernetics in biology, happened before Wiener's Cybernetics. So, it is evident that we can conclude feedback and cybernetic systems were ***tacit*** notions about 5000 BC, ***implicit*** notions about 300 years BC in the elaborations of water clocks, and very ***explicit*** notions, since Socrates and Plato, and in biology, since, at least, 1878. We would like to reiterate that, not just the notion, but even the term "cybernetics" was used since Plato and Socrates, as self-government or self-control. *So, what is new about, control, feedback, feed-forward, cybernetics, etc.? What is new is related to the new technologies, not the notion, the concept, or the term used to describe these main concepts or notions.* We are reiterating this historical fact because it is a main purpose of this article to point to it which points, as well, to the intellectual and practical necessity of intellectual works oriented to Cybernetic Philosophy. This is why we are reiterating this important issue in different contexts.

The above conclusion is important for perceiving cybernetics as probably related to causes and/or effects of evolutionary processes. We can make here the analogy with evolutionary methodologies in systems developments which are cause and effect of cybernetic relationships among activities as well as among methods used in any systemic methodology and not just those oriented to systems development. Clear examples are Action-Research, Action-Learning, and Action-Design. Are these kinds of processes the *cause or effect of cybernetic processes*? The answer is evidently: both. They need to have an explicitly set cybernetic methodology

and when we apply it then it generates cybernetic relationships. We may suggest taking this much-known example as analogical thinking support; which may facilitate why our answer was: <u>both</u>. That is, cybernetic relationships are both: cause and effect of evolutionary and co-evolutionary processes. If Einstein is right, then both sides (of the interlocution) do not understand each other and the best they can do is to find ***common*** grounds in order to have more effective ***commun***ication. This common ground may be to accept that they are on opposite sides, but this opposition is not necessarily a contradiction, but it may be based on *polar opposites*. If this is accepted, then it is a very effective step to move from sterile debate to fruitful dialogue. Management of polar opposites requires cybernetic skills, i.e., identifying cybernetic relationships between both sides opposing intellectual perspective. Should the philosophy of dialogue be part of the philosophy of cybernetics?

Getting back to the analogy of cybernetics methodologies, we may conceive the plausibility that similar situations happened in the context of Natural Evolution and especially regarding the noosphere in which context are inserted human beings thinking. The synergies observed in cybernetic methodologies, for example, are Action-Research, Action-Learning, and Action-Design are part of the emergent properties of these methodologies. A reductionist may say these analogies are not valid because human beings have purposes and Natural Evolution does not. In this case, we may ask: Is it possible for a non-telic evolution to evolve in telic components? We never got an answer. It is possible that we were not able to understand it because we do not have an intellectual background in Biology or Chemistry. But, any human thinking has its frontiers and this would not mean that we have to stop thinking. In these situations, one may remember and remind the interlocutor of Einstein's phrase: "*You don't really understand something unless you can explain it to your grandmother*".

It may have been generated as an ***emergent property*** of evolutionary processes due to 1) an increasing complexity of evolution at a given time period, and/or 2) an increasing complexity of the human brain, as the product of dealing and adapting to its changing environment, which complexity is, in turn, increasing. As a co-evolutionary process, it necessarily requires cybernetic relationships. If this is correct, then, we would have positive feedback loops between internal and external complexities.[38] This, which is highly <u>probable</u> now, may have also happened at the beginning of an evolutionary process.

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[38] Thomas Marlowe suitably commented, on increased complexity, that he "heard the (scientific) claim in the past week that average intelligence, at least in industrialized societies, has increased by

We underlined the word "probable" in order to stress that we are referring to a *plausibility* generated by 'abductive' reasoning; which; frequently, provides input to inductive or deductive logic in order to be validated or invalidated. This is one of the many reasons why we called this article an essay.

What we may assert with more certainty (because of the empirical evidence that we can perceive) is that there seems to be an increasing acceleration in the complexity in both: human thinking and doing, including scientific and technological thinking/doing. This exponential increase of complexities makes evident that t*he whole system is getting even acceleratingly greater than its sub-systems components and each subsystem acceleratingly greater than the sum of its parts.* Consequently, Modern Science and Engineering discovered, this time empirically, that Aristotle was right in his metaphysics when he affirmed that the ***"the totality is not, as it were, a mere heap, but the whole is something besides the parts"*** [39] (Cohen & Reeve, 2020) [Italics and emphasis added]. Interpretations of this phrase has been observed and repeated by many Systems Thinkers, scholars, and researchers from many fields. For example, (Kramer & deSmit, 1977, p. 1) affirms that

> "[t]he evolution of engineering from energy supply to control theory … has led to computer and automation, from the simple thermostat to the automatically piloted and self-correcting rocket of today … When we speak of space craft, large airplanes or ships, the mechanical, electrical and other systems prove so dependent on one another, that the proper functioning of the system as a ***whole*** is largely determined by these interrelations" (Kramer & deSmit, 1977, pp. 1-2) [Emphasis and italics added].

As it is known, the more complex are systems and processes, the more potential emergent properties the whole may have; which are not present in any of their parts. Frequently, or mostly, these emergent properties are due to cybernetic relationships.

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30 points (on someone's scale). This indicates at least increased potential or ability on whatever characteristics were measured by that scale or those scales.

[39] Many authors interpreted this phrase in its more used expression, i.e. *"the whole is more than the sum of its parts"*. This interpretation of what Aristotle meant is not necessarily correct, unless the interpretation is an analogical one, made from another intellectual perspective, i.e., in another context, using less technical terms, or translating the phrase into a metaphorical expression.

4.5. Gestalt and Cybernetics

According to Kramer & deSmit (Systems Thinking: Concepts and Notions, 1977): "In 1924, "the German physicist Köhler… in his book on physical '*Gestalten*' gave the first impulse toward what could be called general system theory. *He dealt with "Gestalten" (whole) from physics*." [Italics added]. He did not succeed in creating a general system theory because he could not identify analogies between organic and inorganic systems. Then in 1925 Lotka (Element of Physical Biology, 1925/1956)[40] introduced the notion of 'open systems', i.e., systems interacting with their environment or, what we may call, co-system or supra-system. (Kramer & deSmit, 1977, p. 3). This supported the creations of analogies between mechanisms and organisms. It is good to notice that this was in 1924 and 1925 and it was in the field of physics.

Consequently, it is also important to notice that different disciplines as physics and biology allowed the initial steps toward a General Systems Theory, by means of generating *analogies between physical gestalt, psychological gestalt, and biological systems*. This requires and generates *interdisciplinary communication* which was part of the processes that lead to "General Systems Theory" and a renewed explicitation of the notions of whole, goal, and Cybernetics. Later, Shannon's mathematical definition of "information" liberated its meaning from its context and, hence, transformed it into a trans-disciplinary concept. This provided more impulse to Cybernetics and General Systems Theory. Consequently, we may think that philosophies of Cybernetics, Systems, and Information are, or can get strongly related.

On the other hand and in parallel to the above developments, research in biology continued showing similar phenomena, for example, "certain phenomena *could not* be explained by molecular biology. One of the great founders of General System Theory, Ludwig von Bertalanffy pointed that out as early as 1928" (Kramer & deSmit, 1977, p. 2) [Italics added]. This was the reason why von Bertalanffy started stressing the need for *oganismic biology* and wrote his first, much-known book "General System Theory", in which he made abstractions and generalizations from biological and electro-mechanical control engineering systems in order to identify commonalities[41]

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[40] Referenced by (Kramer & deSmit, 1977, p. 10)

[41] We are using the word "commonalities", here and above, in its cognitive sense, i.e. representing what has been identified as common features, form, relations, structures, etc. in different concrete objects, in any process of *abstraction,* specially , but not uniquely, analogical thinking and generalizations, form abstraction , relational abstraction, etc. We are not, necessarily referring to "tertium comparationis", at least, not to its rhetorical sense of metaphor or similitude.

and the abstract notions on which he construed his Theory. It is good to notice that von Bertalanffy did not just make analogies, but, supported by analogies, he made in order to make the abstractions required for a General System Theory. It is important to notice that, because this is one of the aspects that differentiate him from those who just created analogies, which are great but need to be inputs into some kind of abstractions in the context of theories based on some kind of logic, including abductive logic, means/ends logic, etc.

It is also good to notice that all these developments, along with the consolidation of the notion of Gestalt and the continuous creation, in systems engineering, of more complex artifacts and artificial systems, have several things in common, among which are the 1) *wholes* more than the sum of its parts, 2) *'telos'* 3) relationships, i.e., *systems,* which may include 4) *control,* hence 5) *cybernetic relationships*, and 6) *information* transfer relationships These 6 commonalities may serve as an abstraction base for a philosophy that would comprehend the notions of systems, wholes, telos, cybernetics, control, and information. A philosophy in each of these fields may contribute to a general philosophy that would include, as its species, a philosophy of each one of the 6 common notions, meta-notions, or cognitive fields that we just mentioned.

As we anticipated above, the notion of physical gestalt contributed to providing the impulse to von Bertalanffy's General System Theory because it allowed more analogies between the physical gestalts, i.e., physical holes and organic holes. But, another very important historical root may be found in Gestalt psychology, which resulted from the proved ineffectiveness of behaviorism that tried to explain human behavior, similarly to how we can explain robot behavior, i.e., focusing just on input and output and correlating them. The complexity of human beings showed, again, that the whole is more than the sum of its parts.

5. Is Cybernetics Science or Art?

Similar to André-Marie Ampère, Norbert Wiener also defined Cybernetics as "science", though in an implicit way. W. Ross Ashby affirmed in his (An Introduction to Cybernetics, 1956) "cybernetics was defined by Wiener as *the science of control and communication in the animal and the machine*." But, we were not able to find this definition of Cybernetics as Science, in Wiener's book. It is that, possibly, the content of his book and its context

support Ashby's affirmation that Wiener presented Cybernetics as a *Science*.

5.1. A Continuously Increasing Number of Definitions of 'Cybernetics'

Gordon Pask (An Approach to Cybernetics, 1961) affirmed that "[a]t the other extreme [of Wiener's] Louis Couffignal's proposal, put forward as an expansion in 1956, '*La Cybernetique est* l'art *d'assurer l'efficacite* de l'action'…The [created] gap between science and art is filled by a continuum of interpretations." This is what, in our opinion, is, simultaneously, the strongest and the weakest aspect of Cybernetics. The huge number of intellectual perspectives it produces, makes it highly adaptable; but, also, the huge number of definitions that have been produced because of this huge variety of intellectual perspectives is a main source of conceptual confusion and misunderstandings. The latter is produced by the *variety* of senses generated for the meaning of the word "cybernetics" and even the *variety* in its different meanings; where each one of these meanings encompasses many senses. So, in the case of the notion of Cybernetics, we may venture to suggest that it has a ***meta-variety*** regarding the intellectual perspectives it generates. Two levels of variety may easily be identified, among the meanings of the term and in the senses of each of its meanings. Consequently, the following is happening:

1. Cybernetics is ***explicitly*** defined according to the different intellectual perspectives. Robert Trappl, for example, affirms[42] that "more than 100 definitions of cybernetics have been proposed up to 1973". Then, he affirms, that he will make the $(n+1)^{st}$ definition; which is the one that guided him in editing the book (Cybernetics: Theory and Applications, 1983). He defined "cybernetics" as follows:

   > "Cybernetics is the science, craft, and art of communication, computation, and control in the machines, the living being, and the organization." (Trappl, 1983, p. preface xi)

   Notice, please, the 3x3 implicit matrix used by Trappl in order to represent one of the most comprehensive definitions, i.e.,

   a. science, craft, and art
   b. communication, computation, and control
   c. machines, living beings, and organizations

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[42] Robert Trappl referenced (Drischel, 1973) when making this affirmation.

It is easily perceived that Trappl is including ***nine*** (potentially 27) large fields of knowledge and/or practice. This is the result of what Trappl was observing by the year 1983. The reader may imagine how this variety, since 1983, had already exploded by 2021.

2. Writers (including journalists) in the nine (potentially 27) large fields covered in Trappl's definition are using the word "cybernetics" in different ways, even, non-intersecting contexts. This is generating a huge amount of senses that implicitly and continuously are emerging because of the huge variety of contexts in which the word "cybernetics" is being used.

Explicit conceptualizations and definitions of cybernetics and ***implicit*** senses with which the word "cybernetics" is being used in different linguistic contexts are reciprocally feed-backing each other via positive feedback loops, with which the number of conceptions, definitions, meanings, and senses is increasing exponentially. So, it is not surprising that confusion and misunderstandings are also increasing exponentially. Is it not a waste of intellectual assets and academic time that this situation is generating? Does this not suggest the importance, and even the need, for a Philosophy of Cybernetics or, at least, an understanding of Cybernetics in the context of Systems Philosophy, which is its genus? *What applies to systems, in general, applies also, and necessarily, to cybernetic systems, but vice versa is not necessarily correct. Consequently, what applies to Systems Philosophy also and necessarily applies to cybernetics systems, but not necessarily vice versa.*

5.2. Necessity of Structuring and Logics for the Support of Congruent Thinking

What was, briefly, described above is (in our opinion) among the most significant reasons why it is so *important* and getting more and more *urgent* to get philosophical and/or intellectual abstractions, based on the identification of the commonalities of what is being called "cybernetics". This is why we would like to reiterate the *importance and usefulness of getting support from **Systems Philosophy** in order to accelerate a structuring or an ordering of the huge diversity of definitions, meanings, and senses generated by the word and the notion of "cybernetics".*

This is also, in our opinion, why Ludwig Bertalanffy, a philosopher, and a biologist, generated the most comprehensive and structured General Systems Theory (Von Bertalanffy, 1968), in which intellectuals in the field

of cybernetics may find a highly comprehensive, coherent, and congruent Systems Theory, in order to approach a General Cybernetics Theory and, hence a Philosophy of Cybernetics, as a special case in the Systems Philosophy. This is what we are venturing to suggest, instead of basing our understanding of cybernetics on *specialists or expert*s in Biology, Electrical Engineering, Computer Science, etc., who make analogies and not always get them through conceptual analysis and/or synthesis in order to explore their coherence and consistency with, at least, Predicate Logic; which is based on natural language and/or Means/Ends Logic. This analogical thinking is creative, in two senses, as 1) generated by creativity and 2) with potential to be a source of more creativity and analogies creation. This is great but it is not yet a conceptually and logically based theory, a coherent intellectual perspective, or philosophical system.

But, the problem, as we perceive it, is even more complex[43]. There are not just a huge number of definitions of "cybernetics", meanings of the word "cybernetics", and multiple senses in each meaning, but also different notions, cognitions, what is 'cognated', or what is known by cybernetics. This is why different and non-homogeneous notions of cybernetics are present among the most known and reputable "cyberneticians" or "cyberneticists". Let us mention an example of what we are trying to convey,

As early as 1983, Robert Trappl affirmed in the introduction of a book he edited, that "the in-homogeneity of the book serves to present the in-homogeneity that is found in cybernetic research." (Trappl, 1983, p. xi). He was already referring to the lack of homogeneity in 1983, which increased exponentially since then, due to the implementation of cybernetic environments, technologies, tools, applications, etc., which added users from other knowledge fields as well as users in the general public and, hence, the Society at large.

So, it is not surprising that more definitions have been made by now (2021). The meaning of the terms being used is changing at a bewildering and confusing velocity. This is due to the increasing use of the same words in so many different contexts; which are continuously extending the different senses of their respective meaning, as well as generating new meanings, conceptions and definitions. This is why it is so important to initiate research related to a comprehensive Theory of Cybernetics or, even, a

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[43] It is good to alert about the much known difference between "complexity and "complication". Here we are referring to a complex situation that might be represented by a complex notion. Hence, we may have emergent properties.

Philosophy of Cybernetics. In both cases, we may easily, distinguish between genus predicates of systems in general, and the specific characteristic of one of its species; which is cybernetic systems. *We suggest that Cybernetic philosophy would have all the predicates of General Systems Theory or System Philosophy plus the predicates from Control and/or governance theory or philosophy.* This suggestion seems to be a platitude in the context of Predicate Logic. But, sometimes what is evident might not be taken into account.

Means/Ends logic should also be added to Predicate Logic. This dual logical support is, in our conception, a *necessary condition* for any General Theory, Philosophy, or methodology of Cybernetics. Dialectical Logic may also be necessary, at least, for some cybernetic systems or thinking. These three logics would be, in our opinion, the basic pillars of the logical system (or meta-system) required to support a General Cybernetic Theory, Philosophy, or methodology. Different methodologies do not necessarily contradict each other; they may be **polar opposites** and not necessarily contradictory opposites. Even using contradictory opposite may be a cybernetic thinking tool. They may contradict each other and still **congruent** with an external objective, i.e., different thinking methods oriented to the same objective. As an example, we may cite the dialectics applied in legal procedures with the objective to support a jury in identifying the truth. This may be perceived as a cybernetic thinking method or methodology, where the logical whole is more than the sum of its logical parts.[44]

5.3. Adaptability of the Notion of Cybernetics

Getting back to our main objective in this section, we may suggest that the specter between Science and Art in which Cybernetics has been defined and the, consequently, increasing number of senses in which the term, "cybernetics" has been used and defined, has also increased 1) its *Adaptability*[45] and 2) the frequency of intellectual confusions and miscommunications. The latter is one of the main reasons for the importance and necessity of an encompassing Theory or a Philosophy of Cybernetics. This is intellectually and pragmatically needed. Systems Theory and System Philosophy may provide solid support for the

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[44] I suggested the mentioned as the necessary ones. Thomas Marlowe commented that he suggest to add "the modal logic of contingency and necessity, and perhaps temporal logic, and even certain types of non-monotonic reasoning, also need to be considered. There is an extremely useful parallel in the logic of specification of computer processes". Necessary conditions are almost every application domain, but they certainly might not be sufficient condition in pore specific domains. So, I am thankful for alerting me about this clarification.

[45] This can easily be inferred from Ashby's First Law of Cybernetics, "Requisite Variety. i.e., "variety destroys variety". (Ashby, 1956)

effectiveness and efficiency of the required research activities, which are necessary 1) to benefit from the internal variety of the field of cybernetics while 2) minimizing the frequency of intellectual confusions and miscommunications.

This variety may also support the effectiveness of congruent thinking in the context of means/ends logic. In this context, we are referring to what we mentioned above regarding the reference made by Gordon Pask (1961), i.e., Louis Couffignal's definition: '*La Cybernetique est* l'art *d'assurer l'efficacite* de l'action'. Efficacious action, necessarily, requires effective action, with an adequate (feasible) efficiency; i.e., achieving the objective, the 'telos' of the action, with an acceptable efficiency in the resources used and the time required.

This, evidently, requires what we may call "congruent thinking", i.e., oriented to identify the means that are congruent with the sought objective or end. This kind of thinking, usually, requires a combination of 1) explicit, implicit, or tacit means-ends logic and 2) the cybernetic relationships between thought and action, which may be provided by systemic methodology as, for example, explicit, implicit, or tacit Action-Research, Action-Learning, and Action-Design, all of which are related by cybernetic loops (negative and positive feedback).

5.4. Cybernetics and Systemics

The still increasing variety, mentioned above, was an important ingredient in intellectual efforts oriented to make some abstractions and identify the commonalities in the mentioned increasing variety, in the field of Cybernetics. A common feature was the notion of "system" which includes a-temporal and temporal ones. The latter is related to the system of processes. This abstraction issue was addressed by several thinkers, especially by the Biologist Ludwig Von Bertalanffy in his (General System Theory: Foundations, Development, Applications, 1968). This highly influential book and intellectual perspective were one of the most important triggers for what later was known as the Systems Movement: Systems Approach, Systems Thinking, System Theory, and Systems Philosophy.

As it is also well known, these intellectual efforts were organized initially by the *Society for the Advancement of General Systems Theory*, hence the International Society for General Systems Research, which provided the intellectual and the organizational base for the present International Society of Systems Sciences (ISSS). The relationships between the systems

movement and Cybernetics have been so strong, since the beginning that recently was organizationally related by the creation of the International Academy for Systems and Cybernetic Sciences (IASCYS), presided over by Stuart Umpleby, who is a former president of the American Society of Cybernetics and among the pioneers of Second Order Cybernetics. Robert Trappl, honorary president of IASCYS, is among the pioneers in Cybernetics.

The above has been part of the intellectual and practice efforts of what has been called **"Systemics"**; which also includes other related fields such as, for example, information systems, Systems Engineering, organizational systems, social systems, political systems, cybernetic systems, etc. Systemics has been defined as *"System Thinking"*[46]. We define it *as "system thinking and doing"*. This includes the evident reality of Systems Practice made by many professions by means of Applying System Theory and systemic notions and intellectual perspective to their professional activities. This is why we registered in 1984 for an Engineering firm with the name of "Systemics". It was basically oriented to Information Systems Engineering, where the objective was to apply Bertanlanffy's General Systems Theory 1) to the practice of information system engineering, 2) to managerial consulting in this area, and 3) to industrial training. Meanwhile, few professors were applying it to their educational practice.

As the reader can notice, systemic thinking requires implicit and/or explicit systemic doing (at least in the field of Engineering, Management, and other professional practice). To have pragmatic and not just intellectual value, Systemic Thinking should be complemented by Systemic Doing. Both complement and many times require each other. We think that thinking and doing are, most of the time, cybernetically related. Even systemic thinkers generate this kind of cybernetic relationships, as soon as they start their writing activities. It is easy to infer that from Jeremy Horne's **(The Philosophy of Research, 2019)** intellectual perspective regarding the notion of research. Accordingly, a researcher does research, not just thinks about it. S/he relates with her/his doing research with her/his thinking while *doing* the research and by observing the intermediate and final results of her/his research. So, cybernetic loops are unavoidable, even if they are tacit or implicit in many cases.

These cybernetic loops between thinking and doing should be more explicit in engineering and managerial activities as well as in other professional

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[46] See, for example, Andreas Ninck, et. al. (Systemics: Viable Solutions for Complex Challenges, 2014).

practices. In our opinion, and according to our experience, the more explicit the cybernetic loops between thinking and doing, the more effective both of them are. We had the experience that this is true even for managerial and executive activities. This has not just been observed but also expressed by several professionals and managers when referring to the improvement of their effectiveness in their activities. One of them informed me about the positive effect of having these cybernetic relationships even in their interaction with their kids and their education. My personal reaction to his affirmation was: Do you think that there is any education if there were no cybernetic processes? Education reduced to instructing, in order to pass exams, is not education; it may even de-educate some students. We had many conversations and even one plenary debate regarding this issue in several previous conferences of the International Institute of Informatics and Systemic (IIIS). Real Education is bidirectional via cybernetic processes. Otherwise, it would be one-directional lecturing, informing, or instruction. This may be a necessary condition for education, but is it a sufficient one? Elsewhere, we provided more details regarding this issue (Callaos N. , Higher Education or Higher instruction?, 2015)

Consequently, we may conclude that the generalization made by General Systems Theory and Systems philosophy supported 1) many thinkers in a high diversity of *explicit* knowledge fields, including empirical ones and 2) many *implicit* knowledge fields where this knowledge is mostly generated by empirical activities. Both: implicit and explicit empirical knowledge do (or at least may) engage in mutual feedback, in order to identify more generalizations in Systems and Cybernetics Philosophies.

Let us start the next section summarizing what we presented above, especially regarding the relationships we have been referring to, in this article. To do so, we will get the support of visual representation of these relationships via diagrams.

6. Main Relationships

6.1. Cybernetic Relationships between Human Beings and their Environment.

Figure 2 summarizes the cybernetic relationships that human beings have been having for a long time, while trying to control their environments, in order to 1) survive the changes produced in these environments and/or 2) purse their life needs and objectives. This process of adaptation is bidirectional: they adapt to their environments and adapt their environment

in what is under their control to do. In the latter case, they make changes to their environment. Then, consequently, they have to adapt to the changes they generated. The more changes and variety are produced in their environments, the more variety they need in order to be able to continue adapting and, hence, controlling their environment. Let us remind ourselves Ashby's (An Introduction to Cybernetics, 1956) First Law of Cybernetics (Requisite Variety); which was resumed by Ashby with the phrase "just variety destroys variety". The increase in the environment's variety increases the variety in human beings' neural nets; which, in turn, support them in increasing their control of their environments, and so on in continuous cyber-loops.

As we can observe from Figure 2, there are negative (co-regulatory) and positive (co-amplificatory) feedback loops, which increase exponentially the variety and the complexity in both: human beings and their environments. These feedbacks add to the natural loops that we have been referring to, above. Consequently, human beings are facing and dealing with two cybernetic sources: 1) the natural ones because of the evolutionary process, independently to how it is perceived: as generated by biochemical factories or by chemical and information-based feedback. The latter introduces the possibility of an 'intelligence' providing "telos" to evolution. In spite of the controversy created by reductionists and holists, as well as between etiological and teleological perspectives, one thing is certain: the feedback is what allows evolutionary and co-evolutionary processes to exist.

This conclusion and what is represented in Figure 2 do not depend on any intellectual perspective. It is based on the notion of feedback, be it chemical, informational, or a hybrid.

Getting back to human beings, we briefly described in the previous sections historical facts that support the plausibility of concluding that cybernetics is a fundamental way in which human beings interacted and still interact with their natural, artificial, social, and mental environments. Tacit, implicit, or explicit Control Engineering is one of the ways in which human beings interact with Nature; Ampère's cybernetics is one of the ways of socio-cybernetics and organizational cybernetics, Artificial Intelligence is one of the ways in which human beings interact with their minds, etc. All of these are examples of the ways human beings interact with their external environments. Artificial Intelligence and Self-Cybernetics, including the different schools of stoicism, are among the ways in which human beings interact, or try to interact with their internal (mental, emotional)

environment. This may suggest that there are the following kinds of cybernetics:

1) Related to *external* interactions (control and co-adaptation to external environments, i.e., a) natural and b) social ones) and
2) Related to *internal* interactions, i.e., a) self-cybernetics (self-control) and b) self-interaction for art, Artificial Intelligence, etc.

Human beings try to control their environments, hence producing changes, more variety and more complexity in their environments.
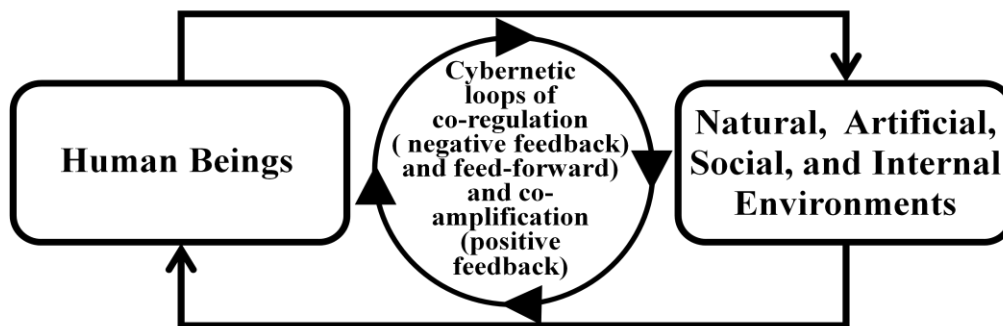
The increasing variety and complexity in the environments generate an increasing variety in human beings and an increasing complexity in the average of their neural nets. This is required in order to continue being able to control environments with more variety and complexity.

Figure 2: Cybernetic relationships between Human being and their environments as a combination of 1) their goals and needs, 2) the changes they make in their environments increasing their variety and complexity, and 3) the corresponding increasing of variety and complexity in their neural nets, as a consequence of the learning process they have while interacting with their environments via "essay and error" and using different logics as , for example, Means-Ends, Inductive, Deductive, Abductive, Predicate, etc. Logics.
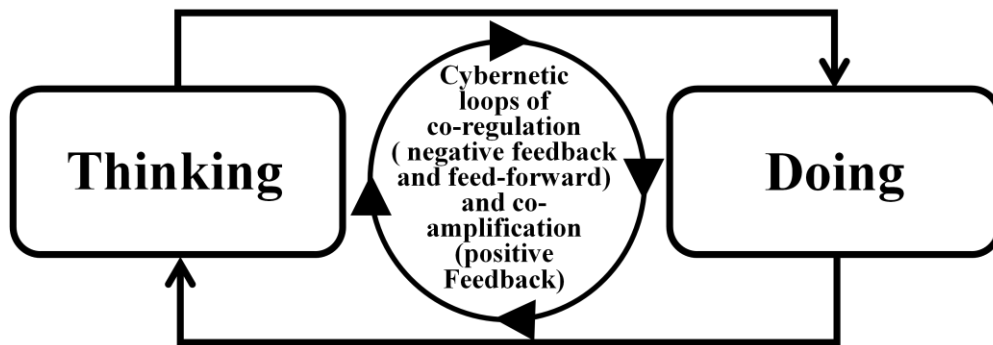
6.2. Cybernetic Relationships between Thinking and Doing

Figure 3 shows the implicit or explicit relationships between thinking and doing, which are typical in a systemic perspective regarding these two activities. A more comprehensive systemic perspective would include the environment the cybernetic relationships with the environment, as it will be

shown in figure 7. In this context, both thinking and doing would also have explicit cybernetic relationships with the environment.

An important issue we have confirmed with our experience (of about 35 years with more than 100 real-life projects) is that these cybernetic relationships are more effective and efficient (in time and in human resources) when they are made explicit and used in as many team meetings as possible. This is experience-based knowledge. We have been trying to make it explicit via several publications, so, it is not tacit knowledge anymore.

Intention, 'telos,' imagination, different logics (specially means-ends logics), designs, Plans, etc.

Source of learning. more data, learning, experience, more insights, especially those oriented to re-doing, re-search. feasibility issues, inputs for tradeoffs re-planning,, etc.

Figure 3: Implicit or explicit Cybernetic relationships between thinking and doing. The more explicit these relationships are made the more effective and/or efficient that may be. This explicitness may increase the ineffectiveness the process as well as its efficiency. Our experience tell us that if these relationships are applied and then it is feasible to ma explicit incremental planning is made as for example the one recommended by (Braybrooke & Lindblom, 1970), which may also be used for designing an evolutionary or co-evolutionary process, with potential synergies or emergent properties,

Up to the present, as we informed in the introductory section, we used the notion of "thinking" and "doing" in their general etymological meaning (footnote 1). In this section, we will use these notions with their meaning in

Lonergan's "generalized empirical method" (or critical realism[47]). This meaning does not contradict the general etymological one, but it is more precise and analytical. By no means are we interpreting Lonergan because we do not have the required Lonerganian context to interpret him? We are just trying to apply the most important aspect of his intellectual perspective to the objectives of this article.

Tad Dunne affirms that in Lonergan's Generalized Empirical Method "model of the *thinking* and choosing person, consciousness has four levels – experience of data, understanding the data, judgment that one's understanding is correct, and decision to act on the resulting knowledge." (Dunne, 2021). We may notice that Dunne calls *thinking* consciousness' levels are actually Lonergan's process of *knowing.* Accordingly, we suggest the following plausibility*:* our thinking is supported by our knowledge; which, in turn, is generated by our thinking processes. If we accept this suggestion, then Lonergan's intellectual perspective may support more clarification of the cybernetic relationships between thinking and doing and why they have been so consubstantial with human beings thinking/doing throughout the known history.

6.2. Bernard Lonergan, JS, and Cybernetics: Cybernetic Relationships in Knowing (Thinking) Processes.

Before continuing with the above reasoning, let us insert a section related to the most basic of Lonergan's notion, especially because their precision is very supportive and because Lonergan's Philosophy is, in our opinion, 1) the most related to First and Second Oder Cybernetics and, hence, the best intellectual and practical support that Systemics and Cybernetics may ever have. Almost all parts of Lonergan's Philosophy are a manifestation of First Order Cybernetics, as well as whole thinking and writings. As a whole, his philosophy is also the expression of a Second-Order Cybernetics as has been well shown, at least, in Laracy, Marlowe, Valdez, & Liddy's (Cybernetics of Observing Systems and Lonergan's Generalized Empirical Method, 2019) and Laracy's (Epistemology and Metaphysics in Interdisciplinary Communication: Insights from Ian. Barbour and Bernard Lonergan, SJ, 2019).

We have a high level of certainty that Lonergan's Philosophy supports the intellectual perspective of Lonergan 1) would benefit and accelerate the

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[47] The tradition of critical realism is associated with Ram Roy Bhaskar, but critical realist, as for example, (Walker, 2017), considers that Lonergan is "consonant with the thought of Bhaskar and complementary to it."

development of Cybernetics Philosophy and 2) would enrich Systems Philosophy with more precision and intellectual rigor. Lonergan has the not frequently found talent of being simultaneously comprehensive in his knowledge and deep in his understanding.[48]

It is a high intellectual risk to try to capture, in diagram(s), what relates some of Lonergan's notions to the objective of this article. But, since 1) Lonergan affirmed that *"the diagram is more important than…is ordinarily believed"*[49][Italics added] and 2) and he used diagrams in the blackboard to illustrate his intellectual perspective, then we decided to take the risk of illustrating via diagrams what was interpreted[50] from Lonergan writings.

In the context of Lonergan Philosophy, figure 4 summarizes the cybernetic relationships between thinking and doing (facilely and coarsely represented in figure 3), but figure 4 provides more details and precision. Each term is used with the precise meaning it has in Lonergan's philosophy.

As easily can be noticed from figure 4, the cybernetic relationships are not just between cognition (facts-based knowing) and deliberation for doing (action-oriented knowing), but also inside of both processes. It is also easy to notice that *"insight"* is the main notion on two sides of the diagram (cognition's "way-up" and action's "way-down, i.e., in abstraction and concretion, in facts-based-knowing (cognition) and action-oriented-knowing (deliberation).

The notion of "insight" required, at least, a book of 875 pages to be presented by Lonergan. He provided several contexts and, hence, amplified its meanings, in other books. So what can we say here in a few words? The most important of this notion (in the context of this article, its purpose, and its limitations) is that it refers to **wholes (related** *set of external and/or internal data)*, which are continuously being generated and used during our mental processes that are oriented 1) to facts knowing and 2) to deliberations before acting. It is the emergence of unity, of a whole from multiplicity. This is why "insight" is what unites and what is common (hence communicate) all our mental processes in knowing and in

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[48] I am, personally, grateful to Father Laracy, JS and Thomas Marlowe for sharing with me what is related to the writings of Father Lonergan, JS. As I told them I wish I would have known about him when I was young, because he would have accelerated my academic and professional development. The more I read Lonergan, the more I am ware about the great impact his thinking would have been made in both: my thinking and my academic and professional practice

[49] Referenced and quoted by (Crowe, 2004, p. 33)

[50] We are referring, mainly to interpretations made by Scholars on Lonergan. I personally do not think I have the required comprehensive background on Lonergan to interpret him. This article is based in interpreting other interpretation and to verify them when it is possible.

deliberating, in episteme and in doxa, in Science, in Engineering, and in Art. It is the cognitive identification of a pattern that *relates and unifies* a multiplicity of parts. Being a whole, "insight" has emergent properties that are not observed in the parts of the whole. This is a fundamental notion, probably the most fundamental notion in the Systems Approach, and especially in complex systems.
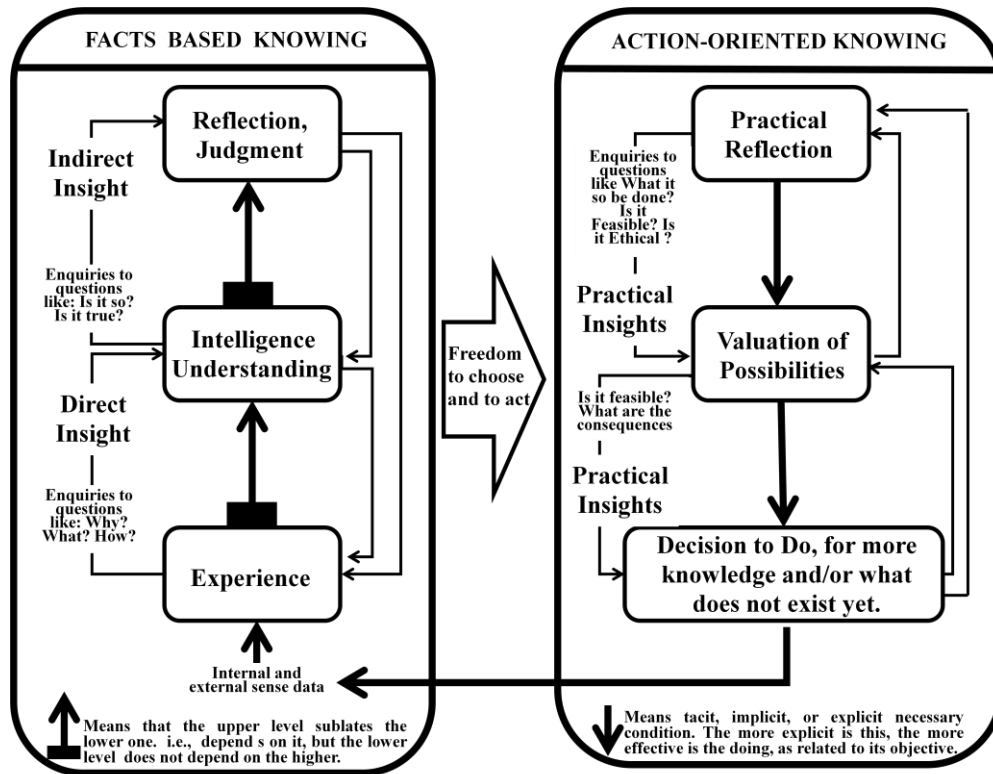

Figure 4: Cybernetic relationships inside bad between "Fact Based Knowing" and "Action Oriented Knowing" which is required for "doing", and part of it. It also represents the cybernetic relationships between "abstraction" and "concretion". These cybernetic relationships may be co-regulative, via negative feedback, or co-amplificatory, via positive feedback.

A good summary of the notion of Lonergan's "insight" for the purpose, context, and limitation of this article is the one given in the internet Encyclopedia of Philosophy (A Peer-Reviewed Academic Resources) by Tad Dunne (Dunne, 2021).

We think that the following short text of Dunne may be highly supportive in grasping the idea about Lonergan's notion of "insight" as well as for supporting an understanding of figure 4. Dunne affirms that the goal of Lonergan's Generalized Empirical Method (GEM), of cognition, is

"a *set*[51] of insights into the data of cognitive activities, followed by a personal verification of those insights… So, in GEM's model of the thinking and choosing person, consciousness has four levels – experience of data, understanding the data, judgment that one's understanding is correct, and decision to act on the resulting knowledge. These are referred to as levels of *self-transcendence*, meaning that they are the principal set of operations by which we transcend the solitary self and deal with the world beyond ourselves through our wonder and care….

…

When we expect to understand anything, our insights fall into two classes. We can understand things as they currently function, or we can understand things as they develop over time. Regarding things as they currently function, we may notice that we have both **direct insights** and **"inverse" insights**[52]. These correspond to two different kinds of **intelligibilities** that may govern what we aim to understand. Lonergan's use of "intelligibility" here corresponds to what Aristotle referred to as "form" and what modern science calls "the nature of." (Dunne, 2021). [Emphasis is Dunne']

The other very important Lonergan notion for the purpose of this article is Lonergan's ***"emergent probability"***, which supports, via probabilistic or statistical terms, the notion of emergence of properties in the whole, in the system, that are not present in the parts. Both (probability and statistics) are extensively used in Science, Engineering, and Technology. Consequently, the intellectual base on which Lonergan's notion of "insight" is well understood via 1) empirically used means and 2) his notion of "emergent probability".

Lonergan's notions of "insight" and "emergent probability" provide dual support for his intellectual perspective regarding cognition and deliberation, as well as regarding abstraction and concretion. Hence, both notions are fundamental to reading figure 4 and the following figures, even though we are not using the precision of Lonergan's notion in them, but general terms, more accessible to the general reader.

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[51] We emphasized and italicized the word ***"set",*** in order to notice that the notion of "set" that is what Dunne uses. In the following paragraph, he uses the notion of *relations* among the parts of this set which is, by definition, a *system*. As a system, it is then a whole, characterized by emergent properties, not to be found any of its parts.
[52] ***Direct insight*** is to get the point, the answer to a question, to the reason of something; while *inverse insight* is to get the point that there is no point, that the answer found is not the right answer, and something in the reasoning is not right.

But, to provide a non-detailed explanation of what is this Lonerganian notion of emergent *probability,* let use the description we provided above (section 2) of Lonergan's notion "scheme of recurrence" and a metaphor.

1. In section 2 we presented what Lonergan described as a "scheme of recurrence" and noticed that he was referring to what we do in cybernetics and in Control Theory is known as feedback negative and positive feedback. 2. A good metaphor (even an example) used by Michael Bretz in the appendix of his article (Emergent Probability A Directed Scale-Free Network Approach to Lonergan's Generic Model of Development). He says that to ride a bike, the rider needs to simultaneously manage five "schemes of recurrence" (feedbacks). The probability of riding the bicycle with no training is very low because it is related to the multiplication of five probabilities that are low because of lack of training in each skill "schemes of recurrence". Consequently, a trainer would remove the necessity of some of these "schemes of recurrence" (feedbacks) until the rider gets the other skills ("schemes of recurrence"). Helping the trainee, in each of the required 5 skills, increases her/his probability of handling the five of them at once.[53] Once the rider does it, then s/he immediately gets the emergent property of riding a bike. This is because the rider got the next level, which a ("schemes of recurrence" capable of controlling the other five. This metaphor, and even example, help apprehend the notion of meta-control, i.e., control of other controls at the lower level, i.e., "schemes of recurrence" composed of other "schemes of recurrences", transcending them but requiring them for their own level of existence at a higher level. This well illustrates the Lonergan notion of "sublation" we referred to, for figure 4.

So, meta-levels of "schemes of recurrence" are what characterize Lonergan's levels of knowing, shown in Figure 4. It also explains the notion of "sublation" as well as the emergence of the different kinds of "insights", included in the same figure.

Let us note that Figure 4 includes what has been called "The Way Up and the Way Down" in Lonergan's Intellectual perspective[54]. The way up is the process that goes from experiencing to understanding to judging. On the way down, higher levels exert influence and control on lower activities. Let us try to delineate these two movements more clearly. The way down is

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[53] We may add to this example, "the training wheels for young children" as suggested by Thomas Marlowe. The training wheels would be supporting the production of the emergent properties while avoiding injuries to the young children and simulating what their parents would for training them.

[54] See, for example, (Cronin, 2001) (Cronin, Foundation of Philosophy, 1999, p. 202)

applicable to any kind of concretion: Science, Engineering, Art, Ethics, etc. Lonergan is explicit about that.

As we noticed above, "sublation" is a very important notion in Lonergan's Philosophy. It is probably the most important one after his notion of "insight". He, explicitly[55], differentiated his notion from the one that Hegel used. Lonergan asserted that

> "what sublates goes beyond what is sublated, introduces something new and distinct, puts every-thing on a new basis, yet so far from interfering with the sublated or destroying it [as in the case of Hegel], on the contrary, needs it, includes it, preserves all its proper features and properties, and carries them forward to a fuller realization within a richer context." (Lonergan B. J., 1990, p. 241)[56]

Consequently, we think that it became evident that Cybernetics may support and may be supported by Lonergan's Philosophy. So, we strongly believe that Cybernetics and Lonergan's Philosophy have cybernetic relationships between both of them and these cybernetics relationships include co-regulative negative feedback and co-amplificatory (synergic) positive feedback. We can also conclude that a similar situation might happen between Lonergan's Philosophy and Systems Philosophy. Figure 5 represents our strong belief[57]. In Lonerganian terms and notions, Figure 5 requires answers to questions that would generate 1) understanding via direct or negative insights and, hence, 2) reflection and judgments via indirect insights so we can make judgments about the correctness, the adequacy, and the intellectual value of what is suggested in Figure 5.

In another article, we will try to provide more justification for this strong belief of ours.

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[55] (Lonergan, Collected Works of Bernard Lonergan - The Triune God: Systematics, 2009, pp. 446-447)

[56] Quoted and referenced by (Riggs, 2003, p. 17)

[57] We use the word "belief" because of 1) our limited knowledge and understanding of Lonergan's Philosophy and 2) our understanding of Cybernetics is based on Systems Philosophy. So, using Lonergan's cognitional three levels, we may suggest that our strong belief is at the second level of knowing and need to go up to the third level, i.e. from understanding to judgments, by means of reflection related to answering the question. "Is that true? Our present answer is related to the kind of question (suggested by Lonergan): What is that? Why? How? i.e. three of the four Aristotle's causes. This is why we prefer to use the words "belief" or "strong belief"
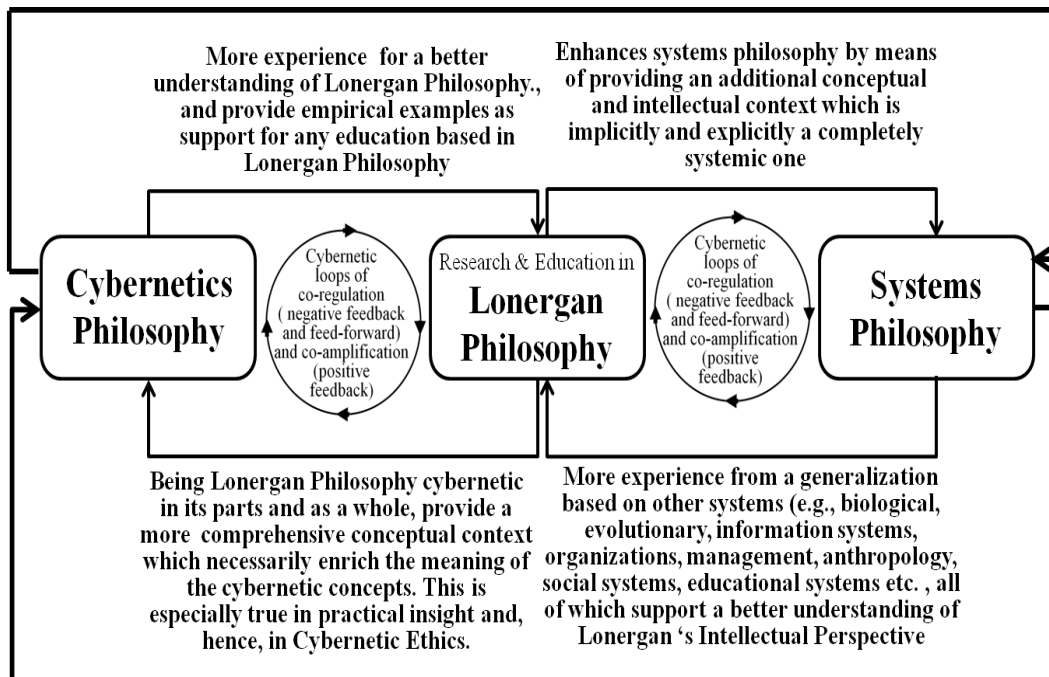
7. Systemic/Cybernetic Relationships

7.1. Thinking and Doing

Now, let us go back to the cybernetic relationships between thinking (Lonergan's three cognitive levels and deliberation, practical knowing) and doing.

We will insert Lonergan's notion wherever is adequate in order to provide more precision to the terms we are using. Figure 6 presents details related to figure 3, regarding the cybernetic relationships between thinking and doing. These details include a subset of the historical facts we selected above in order to provide, in the diagram, historical examples from those selected above.

Figure 5: Cybernetics relationships between 1) cybernetics and Lonergan philosophies, 2) systems and Lonergan philosophies, and 3) cybernetics and systems philosophies. It is good to these relationships include co-regulative loops, via negative feedback, and co-additive (or co-amplificatory) loops, via positive feedback. All of this may generate synergies and, potentially, emergent properties not to be found in any of the related philosophies. In Lonerganian terms this kind of whole would **sublate** the related philosophies.
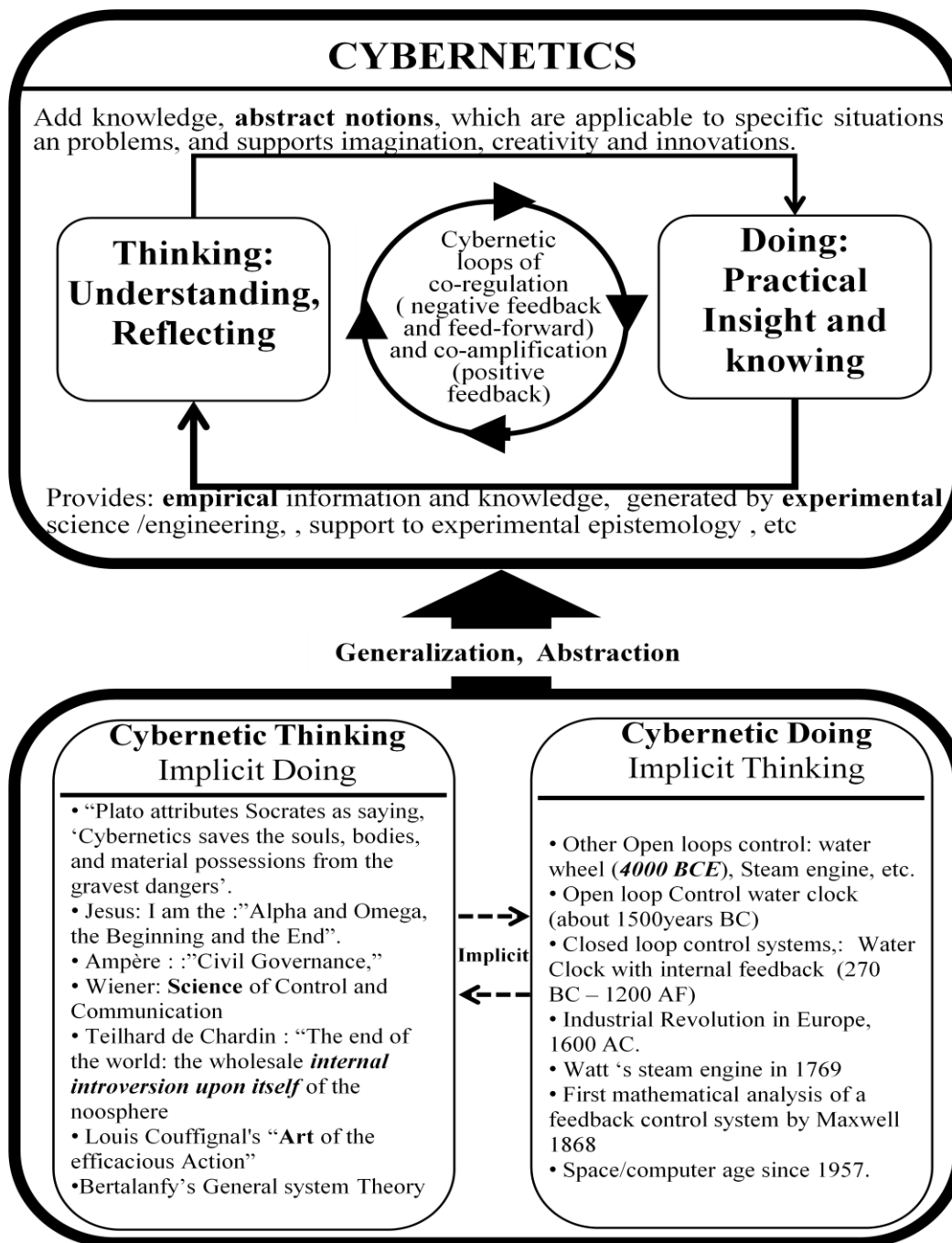
CYBERNETICS

Add knowledge, **abstract notions**, which are applicable to specific situations an problems, and supports imagination, creativity and innovations.

Thinking: Understanding, Reflecting	Cybernetic loops of co-regulation (negative feedback and feed-forward) and co-amplification (positive feedback)	Doing: Practical Insight and knowing

Provides: **empirical** information and knowledge, generated by **experimental** science /engineering, , support to experimental epistemology , etc

Generalization, Abstraction

Cybernetic Thinking
Implicit Doing

- "Plato attributes Socrates as saying, 'Cybernetics saves the souls, bodies, and material possessions from the gravest dangers'.
- Jesus: I am the :"Alpha and Omega, the Beginning and the End".
- Ampère : :"Civil Governance,"
- Wiener: **Science** of Control and Communication
- Teilhard de Chardin : "The end of the world: the wholesale *internal introversion upon itself* of the noosphere
- Louis Couffignal's "**Art** of the efficacious Action"
- Bertalanfy's General system Theory

Implicit

Cybernetic Doing
Implicit Thinking

- Other Open loops control: water wheel (*4000 BCE*), Steam engine, etc.
- Open loop Control water clock (about 1500years BC)
- Closed loop control systems,: Water Clock with internal feedback (270 BC – 1200 AF)
- Industrial Revolution in Europe, 1600 AC.
- Watt 's steam engine in 1769
- First mathematical analysis of a feedback control system by Maxwell 1868
- Space/computer age since 1957.

Figure 6: Historical facts, since at least 5000 BC, are evidence that human beings engineered control and feedback systems in meeting some of their objectives; which represented their intellectual effort in trying to control their environment. Likewise, since, at least Socrates and Plato, the word "cybernetics" was used to represent a notion in human thinking. So, historically, human thinking and doing included cybernetic activities, which may have been implicitly related. Cybernetics, as science/engineering field and as art relates explicitly cybernetic thinking and doing.

Figure 6 summarizes what we showed, identified, or suggested in sections previous to the last one. This is done by means of including a very short list of the historical facts that we selected, and which we briefly mentioned above. A complete account of these historical facts would require several books regarding the history of technology and other sets of books related to the history of intellectual productions, explicitly or implicitly, related to the general notion of Cybernetics. Consequently, figure 6 is a very general representation of the potentially implicit relationships between cybernetic-based thinking and doing and the generalization of these relationships via abstraction and renewed reflections, generated by the empirically observed advances in science, engineering, and technological innovations.

We think that we have shown that Cybernetics is intrinsic to human nature, especially with dealing and interacting with its (natural, social, and internal) environments. Valentin F. Turchin[58] (The Phenomenon of Science: a cybernetic approach to human evolution, 1977) used the phrase "cybernetic animal" to refer to the notion that we are trying to convey here.

7.2. Complexity Increasing

Human beings need to *control their environment*, in any way they can, in order to survive as individuals and as a species. They need to adapt (self-control) and adapt to their environment as much as they can. Both kinds of adaptation require variety in the human brain. By being effective in controlling the environment, necessarily changes the environment, hence the human brain should change accordingly and increase its variety in order to continue destroying the external variety (Ahby's First Law of Cybernetics[59]).

The changes made by human beings in their environment increase its variety and complexity which require and generate more complexity in the neural nets of human beings. This, evidently, represents positive feedback between the complexity of the human brains and human environments.

The three environments: natural, social, and internal, also get more complex and related via positive feedback, hence, accelerating the complexity in each one of them and, consequently, in the human brain.

This acceleration of the complexity of the human brain is continuously generating more complexity in the noosphere. This can be expected to

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[58] (The Phenomenon of Science: a cybernetic approach to human evolution, 1977)
[59] (An Introduction to Cybernetics, 1956)

generate more and more emergent properties, which is a characteristic of complex systems. It may be thought that these emergent properties are caused by negative and positive feedback loops and even by the interaction between these two kinds of cybernetic loops. Synergies, for example, are an example of emergent properties.

Emergent properties would apply to what Teilhard de Chardin meant by the noosphere, as well as to what Vladimir Ivanovich Vernadsky (the father of the notion of the biosphere) meant by the same term. Oldfield and Shaw (V.I. Vernadsky and the noosphere concept: Russian understandings of society-nature interaction, 2006) affirm that "Indeed, for Vernadsky, the noosphere is the latest phase in the evolutionary and qualitative transformation of the biosphere." This could easily be understood as an "emergent property" of the biosphere as a result of getting more complex because of the increasing number and variety of cybernetic relationships among the different parts of the biosphere. Irina L. Trubetskova references Vladimir Vernadsky[60], with the following text: "I look forward with great optimism. I think that we undergo not only a historical, but a planetary change as well. We live in a transition to the noosphere"

Both thinkers (de Chardin and Vernadsky) used the same notion of "noosphere" in completely different contexts and focuses, but meant the same with it, i.e., as a new *evolutionary stage generated by human reason, human mind, and human work.* Lynn Margulis and Dorion Sagan *(What Is Life?, 2000)* asserted that "Both the French paleontologist-priest Pierre Teilhard de Chardin and the Russian atheist Vladimir Vernadsky agreed that Earth is developing a global mind" (p. 170), that they named "noosphere".

Both thinkers agreed that the noosphere is related to **human** reason and the mind. In our opinion, this is, probably, why both used the Greek notion of 'nous", i.e., intellect, the human mind. Both also agreed on a **teleological Universe**. Vernadsky conceived the noosphere as an emergent property of the biosphere which, in turn, was conceived by him as an emergent property of the Geosphere (inanimate matter). Teilhard de Chardin conceived it as the path to Christian Logos (Jesus Christ). In spite of completely different contexts, purposes, and focuses; **both agreed on the human and teleological nature of the noosphere.** This, evidently, contrasts with the reductionist approach of reducing the explanation framework to just the efficient cause, excluding any notion related to a final cause.

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[60] Vladimir Vernadsky, 1945, "The Biosphere and the Noosphere"

7.3. The Notion of "Cybernetics"

7.3.1. Interpreting the Notion of "Cybernetics" in Lonerganian Terms. We mentioned above that there has been an increasing multiplication of the definitions of "cybernetics". This is generated by its multiple roots and branches, all of which are related to human activities. This has created (using Lonergan's notions) an increasing variety of *experiences;* which, in turn, is generating an increasing complexity in *understanding* "Cybernetics". Each definition may be conceived as a direct insight, taking the definer from the realm of experience to the realm of understanding. All of this is generating an increased complexity in the collective understanding of Cybernetics. This is why we think and affirm, with certainty, that "cybernetics" is not a concept, but a notion[61], i.e., a set of related or relatable concepts, with their respective definitions, and relationships, including cybernetic ones. In other words, Cybernetics is a ***complex notion***, with an increasing number of 1) denotations and connotation and, hence, 2) cybernetic relationships among them. This means that it is a *dynamic notion, which is, continuously, increasing its internal variety, complexity, and, hence, its adaptability to apprehending different kinds of experiences and continuously generating direct insights for our individual and collective understanding.* This process is generating a dynamic and evolutionary field of knowledge; which might be, simultaneously, cause and effect of imaginations[62], intuitions[63], and more insights. This would be caused by the cybernetic relationships between 1) experience and understanding (in Lonergan's terms) and by 2) facts and deliberative (practical) knowing (also in the Lonerganian meaning of these terms)

7.3.2. Notion as Cognition and as Description. A concept is defined, but a notion is described, by means of, as we noticed above, a comprehensive set of the most important definitions, the actual relations among them, and the potential relations they may have among themselves and with other notions. The latter include cybernetic relationships.

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[61] We provided some details, regarding the meaning of the word "notion" at (The Notion of 'Notion', 2013). It is enough, for us, here to provide the main conclusion: A notion is a (potentially fuzzy) set of related or relatable concepts (referenced by the same term, along with their respective definitions and/or the different senses in the meaning of a term. ***A concept may be defined, but a notion is described***.

[62] In Lonergan's terms, understanding transcends imagination.

[63] Lonergan's insight might be conceived as "a kind of intuition although it is creative, active, mediated, indirect, fallible and open to revision." (Walczak, 2016, p. 34)

The description of a notion is an external representation of cognition. Notice that the term "notion" and "cognition" have the same etymological origin, i.e.

1. The term "notion" derives from the Latin term "notion"; which, in turn, derives from "noscere", i.e., "come to know," (Online Etymological Dictionary). Pro-Indo-European "root *gno –" to know" ---- In Greek is *γνῶσις gnosis* – knowledge. Pro-Indo-European "root *gno –" to know" ---- In Greek is *γνῶσις gnosis* – knowledge. According to Ekaterini Nikolarea (the non-anonymous reviewer of this article), the Latin term, probably, derived from the Greek.

2. The term "Cognition" derives from the Latin term "cognicioun", "ability to comprehend, mental act or process of knowing,", which, in turn, derived "from Latin cognitionem (nominative cognitio) "a getting to know, acquaintance, knowledge," noun of action from past participle stem of cognoscere "to get to know, recognize," from assimilated form of com "together"… + gnoscere "to know" (Online Etymological Dictionary)

Both cases above derive from the Proto-Indo-European "root *gno- "to know." In 17c., the meaning was extended to include perception and sensation." (Online Etymological Dictionary)

Consequently, we may venture to differentiate 1) *ability* to comprehend/know, 2) *using the ability* to comprehend/know, and 3) what has been achieved by the ability to comprehend/know. The latter would be represented in the respective neural nets (with parallel processing) and the description of a notion would be represented by translating from the respective neural net to semiotic systems, which are natural languages, or disciplinary semiotic systems. In any case, the description is mostly generated and acquired in series, though diagrams may also be used in such descriptions. This interpretation requires more reflection and reflexion. Meanwhile, let us affirm that in the context of cognition and notions we are not, and cannot be, completely lacking the subjective neural nets that, in turn, are a representation of subjective experiences. We need to keep this in mind along with what is left in the article.

7.3.3. Systemic Notion of Cybernetics: A systemic notion may be conceived as a conceptual system related to other conceptual systems and all are based on cognitions which, by definition, are subjective. This may also be conceived as 1) a system of a related, or relatable, set of concepts/definitions and 2) the relation of this system with other external or

intersecting systems of concepts/definitions. A systemic description of a notional system has to relate the described notion (set of related conceptions) with other notions. We need to keep this in mind for the external relationships that we have been making and we will make with more details below. Figure 7 schematizes the main relationships that, at least, implicitly exist between Systems Philosophy, Cybernetic Philosophy, and Cybernetics. These relationships are pretty well known. Our intention here is to make them explicit.

8. A Systemic Insertion of Cybernetics

Because of what has been mentioned above, "cybernetics" cannot be defined, but, obviously, we can add another definition to the huge number of definitions that we already have. As a notion of cognition, it may be described, by means of relating its different definitions and the different senses in the meaning of the most used terms in Cybernetics. A General Theory of Cybernetics is increasingly being needed as well, as we already mentioned above, a philosophy of cybernetics and/or the relationships between Cybernetics and Philosophy and/or the relationships between Cybernetics and Systems Philosophy. Tons of books and articles have been written regarding what we are describing in a few words. For example, the cybernetic loops between abstraction and concretion[64] are what support Action-Research, Action-Learning, Action-Design, trial and error, analysis and synthesis, etc. This is nothing new, but it also relates, from our perspective, Cybernetics with Philosophy of Cybernetics, as well as Systems Philosophy and Cybernetic Philosophy, which is an issue congruent with a main purpose of this article.

What use would have philosophy if we were not able to apply it to our lives, i.e., to our thinking and doing? So, it is evident, as it is in Figures 6 and 7. But for some reason, this is not always taken into account. It is, in our opinion, the same kind of situation, frequently, happening with predicate logic: It is evident but frequently it is not applied. Frequently, people (including scientists) predicate species' characteristics to their genre; which contradicts the most basic notion of predicate logic. Figure 7 is an immediate consequence of predicate logic, but our experience tells us that it should be made explicit, again and again. We have met many people who handle very well predicate logic via symbols and computer languages but, unexpectedly, they do not apply it to their opinions, concepts, and to the

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[64] "Way up" and "way down" knowing according to Lonergan (left and right blocks in the diagram of figure 4, related to his different levels of cognition and deliberation)

way they use Natural Language. It seems a waste of time to reiterate such a platitude, but it is hugely paradoxical why such a much-known way of wrongly relating genus and species is frequently not taken into account, in scientific discourses, let alone in other discourses. We presented in (Callaos N. , The Notion of Intellectual Rigor, 2020, pp. 124-127) a typical example of what is abundant in scientific literature and in academic peer reviewing, regarding what we are trying to convey
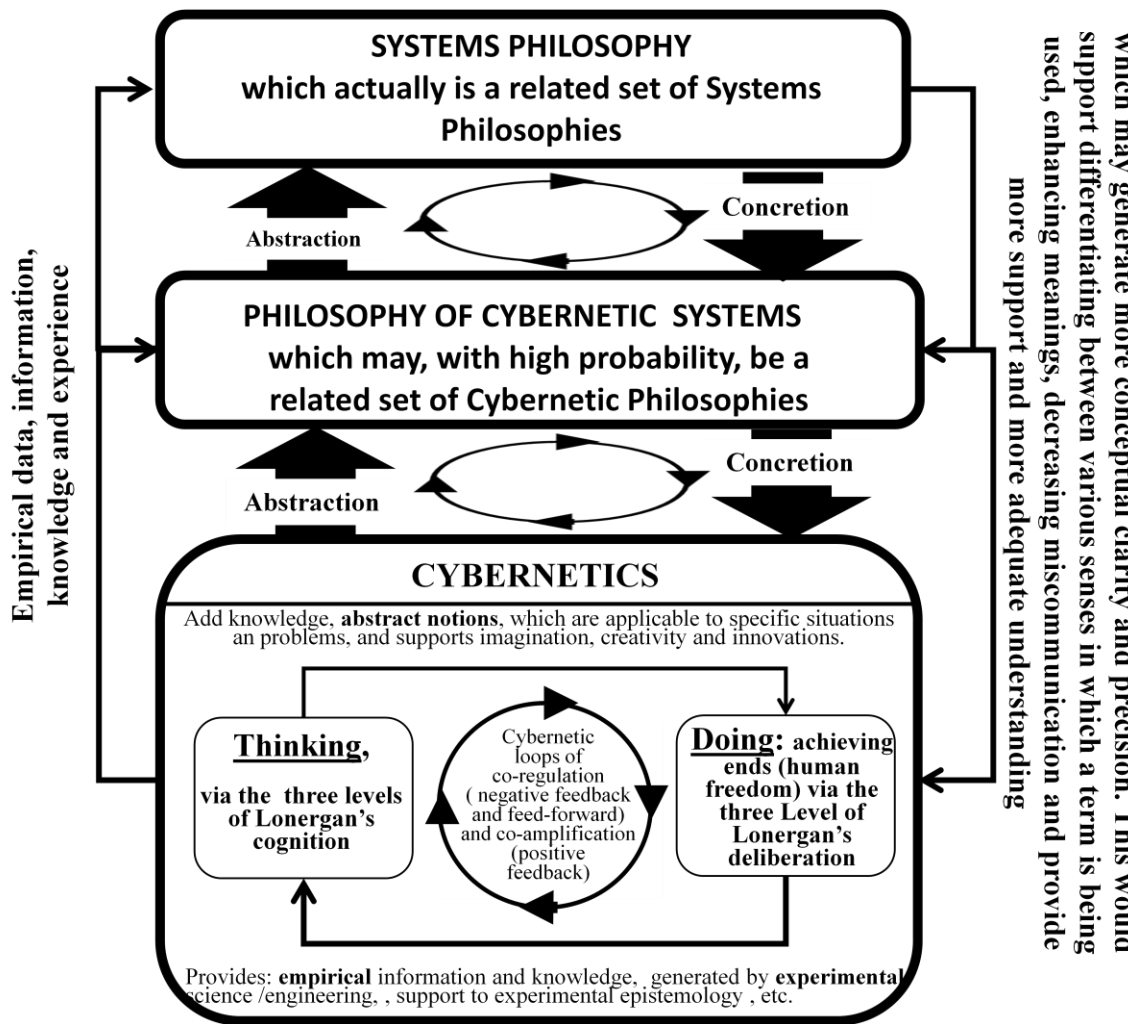

Figure 7: Systemic Insertion of Cybernetics. Cybernetic relationships between: 1) thinking and doing, 2) Cybernetics and Philosophy of Cybernetics, 3) Systems Philosophy and Cybernetics Philosophy, and 4) abstractions and concretions, at representing different levels of generalization/specification.

What may not be, probably, so evident (at least, not explicitly) in figures 6 and 7 are, the cybernetic of co-regulative and co-amplificatory loops, via

negative and positive feedback, respectively. They are real and they exist. Making them explicit, in real-life research and professional projects, may accelerate their synergic effect. Finding a place in our minds for these (existing or potential) cybernetic loops may increase our intellectual comprehension and potentially extend and/or deepen our understanding, of its Lonerganian meaning. This is because having them explicit in our research processes, projects executions or our thinking may increase the probability of the direct insight required to jump from experience to understanding.

9. Systems Philosophy

If a Google search is made with the phrase "Systems Approach", about 6,990,000 results are found; if make a similar search with the phrase "System Approach" about 3,340,000 results are found and a similar search with "System Philosophy" gets 85,700 results and with "Systems Philosophy" 125,000 results are identified. Thousands of books and articles have been written with regards to the Systems Approach or Systems Philosophy. Consequently, what can we add here in few words? The answer is nothing. Our intention here is:

1. To notice that, similarly to Cybernetics, Systems Philosophy is nothing new, and what is new is empirically based.
2. To apply Cybernetic Thinking (and potentially doing) to Systems Philosophy

With regards to the first point, we will limit our supporting sources, our sources on this issue to just two much-known writers, one from a methodological perspective and another from a theoretical frame of reference. Both of them refer to one of the most important notions of the Systems Approach, as it is the case of perceiving and conceiving wholes.

9.1. Systemic Wholes.

Richard Mattessich asserts that the systems approach, philosophy or methodology "grows out of holistic view… It can be encountered in many philosophers…. Perhaps going back as far as to Heraclitus [500 BC] and Lao Tse [600 BC]" (Mattessich, 1978, p. 299)

Ervin Laszlo[65], mainly, based on Ludwig von Bertalanffy's General Systems Theory, was who first described Systems Philosophy (Systems Philosophy, 1971) (Introduction to Systems Philosophy: Toward a New Paradigm of Contemporary Thought, 1972) (Laszlo E. , 1971). He alerted the reader not to confuse Systems Philosophy with Philosophy of Systems because the latter would be more related to Ontology.

Once again, Laszlo emphasized that there is nothing new in the Systems Approach or Systems Philosophy. The only thing new about it is its empirical support. Right at the beginning of his initial article, he affirmed that:

> "Systems philosophy is the philosophical explication and generalization of the concepts and principles of the contemporary systems sciences and general systems theory. It received its name in recent years, but its roots go back to the beginnings of systematic thinking about the nature of reality. It is a successor to the cosmological doctrines of the Ionian nature philosophers (especially Anaximander and Heraclitus) and to the cosmology of Plato (Timaeus). It counts among its precursors Nicholas de Cusa in Mediaeval thought, and the great metaphysical and process thinkers of modern philosophy (such as Hegel, Bergson, Lloyd Morgan, Samuel Alexander, and Whitehead). *Systems philosophy is similar to these schools in regard to its emphasis on beholding· reality as a process, and attributing meaning to the whole rather than to any isolated part. It differs from them in being able to draw on evidence provided by the empirical sciences for all its principal generalizations.* The Greeks had no empirical science apart from philosophy. Mediaeval thinkers looked to Greece (Aristotle or Plato) and to Christian doctrine for substantiation of their ideas. Modern metaphysical and process thinkers drew on science to varying degrees, being limited by the intrinsically atomistic and mechanistic orientation of modern science in the epoch ranging from Galileo to Einstein. Only in the 20th century has it been possible to evolve a ***holistic*** doctrine on the nature of reality based on knowledge issuing from the empirical sciences. The branches of the sciences which offered, and continue to offer, the clearest and most persuasive evidence for a holistic and yet empirical process philosophy are the so-called systems sciences, and those traditional disciplines where

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[65] Ervin Laszlo based his Systems Philosophy on Norbert Albert Whitehead's **'philosophy** of organism', (Whitehead, 1929) and Ludwig von Bertalanffy's 'organismic biology' and 'General system Theory' (Von Bertalanffy, 1968).

systems concepts found major application. ***Thus the contemporary holistic, yet scientifically empirical process philosophy is a systems philosophy"*** (Laszlo E. , 1971, p. 55) [Emphasis and italics added]

Ervin Laszlo, like almost all writers on the Systems approach, emphasized and reiterated that systemic thinking, approach, and philosophy are oriented to synthesis, generalization, and holism as opposed, respectively, to analysis, specialization, and reductionism.

In this aspect, our opinion is that Ervin Laszlo overstated his support to synthesis, generalization, and holism, which is completely understandable if we take into account the time of his writings, and that the scientific world in his time was more analytical than what might be recommended.

The academic world is still highly analytical, especially if we take into account that most academic promotional systems are oriented to award more those who publish in disciplinary or sub-disciplinary fields than those who publish in multi-, inter-, or trans-disciplinary outlets (conferences, journals, books, etc.). Having written so, and knowing the huge importance of the intellectual movement toward synthesis, generalization, and holism, we have to be alert regarding the *cybernetic relationships*, hence co-regulation and synergies that would increase if we have explicit knowledge about cybernetically relating analysis and synthesis. Knowing that explicitly would orient our thinking and doing toward relating, cybernetically, both intellectual approaches, including scientific thinking and practice. Analysis and synthesis are not just related but they even require each other at the conceptual, notional, and pragmatic levels. Consequently, perhaps, we may present the cybernetic relationships between (the polar opposites[66]) analysis and synthesis, specialization and generalization, as well as between trans-disciplinary and intra-disciplinary research, education, and communication as it is shown in the simple diagram of Figure 8.

We may suggest that Analysis was the preferred orientation in both Science and Philosophy, i.e., they were, in Hegelian terms, the *thesis f*or a long time; and then this thesis generated its antithesis, what has been named "synthesis" in systems thinking and philosophy. Both thesis (analytical thinking) and antithesis (synthetic thinking) create a tension that may move the intellectual domain (Science, Engineering, Art, etc.) to:

1. A Hegelian synthesis or, more plausible,

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[66] We added this phrase thanks to the alert provided by Thomas Marlowe.

2. A higher level of understanding that sublates (in Lonerganian terms) both analysis and synthesis perspectives
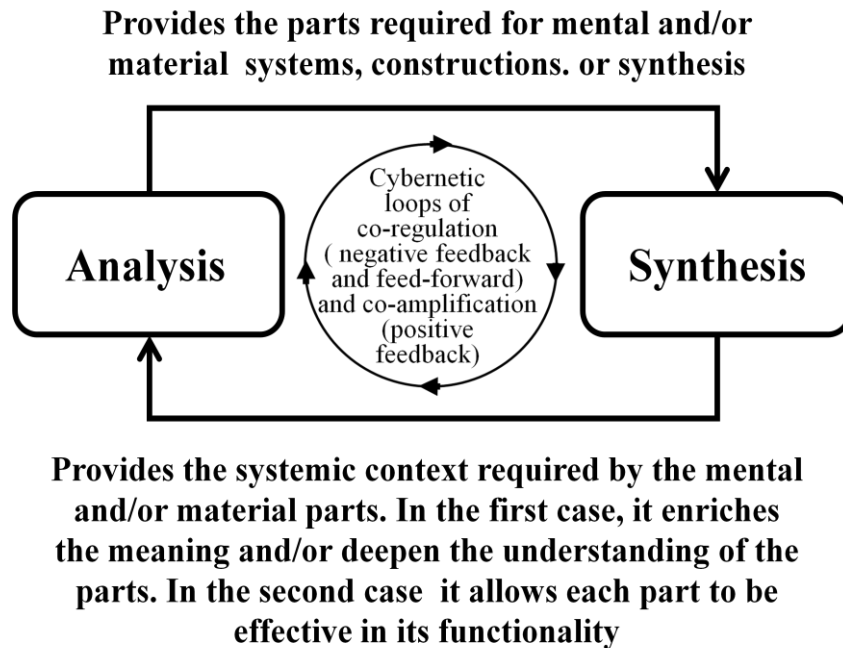
Provides the parts required for mental and/or material systems, constructions. or synthesis

Provides the systemic context required by the mental and/or material parts. In the first case, it enriches the meaning and/or deepen the understanding of the parts. In the second case it allows each part to be effective in its functionality

Figure 8 Cybernetic relationships between Analysis and synthesis, hence, between 1) specialization and generalization, 2) reductionism and holism, and 3) Intra- and Trans--disciplinary research, education, and communication.

It is evident, for us, that Lonergan's sublation is what is applicable in this case and not the Hegelian sublation. Scientific and philosophical analysis and synthesis will not be destroyed but, on the contrary, they will (eventually) support a *more comprehensive understanding*, as would be expected with Lonergan's intellectual perspective. This would be achieved if we relate analysis and synthesis via cybernetic relationships.

If we accept Nobel Laureate Roger Sperry's study and conclusions regarding left-brain vs. right-brain dominance, then figure 8 would represent a more systemic intellectual development for any scientist, be she/he right-brain or left-brain thinker. To intellectually accept what is represented in figure 8, especially with regards to the cybernetic (co-regulative and synergic) relationships, briefly included in the figure, may trigger the development of more holistic thinking. Consequently, if Roger is right, developing the functionalities of our left and right brain would provide us with a more systemic intellect. A relatively easy way to find out what kind of thinker we are, we should identify what kind of thinking we are more comfortable with, and which we feel less comfortable with. Then, we can exercise the kind of thinking we are less comfortable with. This

would provide us with a process of more systemic thinking because we would be increasingly having more holistic thinking instead of predominantly left or right-brain thinking. Consequently, a more holistic, i.e., a more systemic intellectual development, requires intellectual efforts oriented to both analysis and synthesis. The processes would co-regulate each other, via negative feedback or feed-forward, and produce intellectual synergies via positive feedback.

Let us now refer to another Noble Laureate who has a similar reasoning. Murray Gell-Mann, who received the Nobel Prize in Physics for his work on the theory of elementary particles, affirmed that

> "The philosopher F. W. J. von Shelling introduced the distinction (made famous by Nietzsche) between 'Apollonians,' who favor logic, the analytical approach, and a dispassionate weighing of evidence and 'Dionysians' who lean more toward intuition, synthesis, and passion. These traits are sometimes described as correlating very roughly with emphasis on the use of the left and right brain respectively. But some of us seem to belong to another category: the 'Odysseans,' who combine the two predilections in their quest for connections among ideas. Such people often feel lonely in conventional institutions." (Gell-Mann, 1994, p. xiii)

Elsewhere (Callaos N. , The Notion of Intellectual Rigor, 2020), we found a strong association between what Shelling and Gell-Mann called 'Apollonians,' and 'Dionysians with Aristotle's 'Dianoia' and 'Noesis', respectively.

What we are suggesting in Figure 8 is oriented to the development of what we may call (using Murray Gell-Mann's analogy) 'Odyssean' intellect. Consequently, we suggest that a systemic development of the intellect is associated with the cybernetic relationships shown in figure 8, which should not be reduced to synthetic thinking as might have been guessed in the initial period of the Systems Approach or Systems Philosophy. Consequently, if we can apply Systems Philosophy to itself, via the cybernetic relationships shown in figure 8, then we have a real systemic notion of intellectual systemic development; which, in our opinion, is what is being needed now, after the initial intellectual reaction to oppose analysis emphasizing the importance of synthesis. ***This is an example of how cybernetics can nurture Systems Philosophy and not just vice versa.*** Are we referring to some kind of meta-cybernetics if we apply "Odyssean" thinking to Cybernetics? Cybernetics has analytic and synthetic dimensions,

so "Odyssean" thinking is required, at least, in a team or collective thinking.[67]

From the Systems Approach perspective, Figure 8, and "Odyssean" thinking would be more holistic and, consequently, more systemic. The suggestion to apply "Odyssean" thinking to Cybernetics and Systemic, or what is suggested by figure 8, may generate important intellectual synergies with potential pragmatic value. In the introductory section, we referred to an experience (in its Lonerganian sense) of about 35 years that shows the pragmatic value of a methodology based on the above diagrams and specifically on the one shown in figure 8.

One possible way to achieve "Odyssean" thinking maybe via inter-disciplinary conversations, between analytically and synthetically oriented people, all from the area of cybernetics and/or systemics. We include in these areas the methodological dimension and practical knowing or thinking.

How about co-learning and co-researching community with analytically and synthetically oriented people? Would they be able to communicate with a minimum of effectiveness? If so, would this be a potential platform for developing holistic thinking in the sense of "Odyssean" thinking? Does that have any pragmatic value, besides the intellectual one?

9.2. Teleology in Cybernetic Systems:

Even the word teleology was coined in the 17th Century; the controversy surrounding a teleological perspective of nature is a very old one. Consequently, as the reader can imagine, tons of books and articles have been written on this issue and its controversial nature. Our objective in this article will be limited to, briefly, referring to the following issues:

1. Teleology is not a new intellectual perspective. It is as old as the related controversy.
2. This controversy does not impact Cybernetics, because no matter if nature is teleological or not, human beings are teleological beings/ this is a fact.

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[67] It has a high intellectual and pragmatic value to add Thomas Marlowe's comment on this issue. He wrote on "practical value of "Odyssean" thinking: I would wager (a lot) on the potential value of this in the security domain." I would also wager a lot, in this and many other domains, including information systems developments, deployment and maintenance.

3. At, least two different selection processes should be made in cybernetics thinking or doing: 1) selecting the end and., then, 2) selecting the respective means. Consequently, at least two deliberations, practical thinking with their practical insight would be required in, at least, two dimensions: the pragmatic and the ethical ones.

9.2.1: Two perspective regarding Nature: The German philosopher Baron Christian von Wolff (1679-1754) coined in 1728 the Latin term 'teleologia'. According to Ekaterini Nikolarea[68] 'teleologia' derives from "*telos*" – "end , finish" + *logia*, which comes from *logos*, that is, "word or articulated word "/ "discourse" and/or "reason" - "Science".

This means that Teleologia was coined by Wolff to refer to the Science (Logos) of the telos, i.e., the "final end", i.e., the "final cause", in Aristotle's terms. So once again, "There is nothing new under the sun." The four Aristotle's causes are well known: *the material, efficient, formal, and final co-causes of change*. Since Wolff was a Scholastic scholar, he knew very well the four Aristotelian causes of any change. He actually used the term "efficient" to refer to the other sciences he proposed. Wolff's following text is related to what we are referring to:

> "A twofold reason can be given for natural things. One reason is to be found in the efficient cause, and the other reason in the end. Reasons which are sought in the efficient cause belong to the sciences which we have already defined. Besides these sciences, there is still another part of natural philosophy which explains the end of things. There is no name for this discipline, even though it is very important and most useful. It could be called teleology. (von Wolff, 1728/1963), §85[69]

This division, made by Wolff, represents two main ancient philosophical perspectives regarding Nature: what he calls teleological is an intellectual perspective represented by philosophers like Anaxagoras, Plato, Aristotle, Scholastics, Medieval Arab philosophers, as Avicenna, etc. Many philosophers, like the ones just cited, provide a teleological explanation; while, on the other hand, philosophers like Democritus, Descartes, Spinoza, etc. offer mechanical or causal explanations. Still, others like Leibnitz and Lotze tried to present both interpretations as related to each other as, for example, a teleological perspective as the internal reason of concatenated causal or mechanical events. (Ferrater-Mora, 1969b, p. 767). It might be

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[68] Non-anonymous reviewer of this article
[69] Quoted and referenced by (Hamid, 2019–2020)

suggested that a systemic-cybernetic perspective is closer to Leibnitz and Lotze.

9.2.2. Cybernetics Has, Necessarily, to Relate both Perspectives: Cybernetics is the new intellectual perspective that relates teleological with mechanical perspectives, i.e., final causes with efficient causes. In cybernetic practical knowing and doing, it is necessary to relate mechanisms with telos, purposes. There is no other way around. Consequently, the controversy is not an issue in Cybernetics, especially in cybernetic practice. All cyberneticians relate both telic and efficient causes, backward and forward-thinking, i.e., try to design and implement systems oriented to a purpose by means of using mechanisms. This is what is *common* to all cyberneticians, especially in cybernetic practice.

What *differentiates* cyberneticians are:

1. Different ways of relating both kinds of causes.
2. What they understand by telos, purpose, objective, etc., whether it applies to human beings, or also to Nature.
3. Their emphasis on the mechanisms or on the telos, for which these mechanisms are designed, implemented, used, and maintained.
4. Their awareness and willingness to address the ethical issues related to both, ends and means, telos, and mechanisms.
5. Their selection on what "cybernetics" is, i.e., their selection among the increasing multiplicity that exists in the definitions of Cybernetics, which we mentioned above.

9.2.3. The Ethical Dimension in Cybernetics: The notion of teleology can be conceived from two different, but related intellectual perspectives and this is especially correct in the field of cybernetics. It may be perceived as an *option* or as a *determination*.

As an *option*, it is related to the freedom of human beings to decide and select the most adequate ends and means. The selected means would determine their pragmatic effectiveness in achieving the selected end. As *determination*, it is perceived as a consequence of organic chemical factories interacting with the environment. i.e., a physic-chemical factory, both of which obey natural laws and evolve according to random mutations and selection of the most apt or adequate mutation.

Cybernetics is based on both: 1) telos, purposes chosen freely by human beings and 2) pre-determined mechanisms, which operate according to

efficient causes that are used as means to design and implement electro-mechanic systems required for human purposes.

This is why in Cybernetics there are two processes of practical thinking (with their respective Lonergan's practical insight): one is related to the end selection and the second is related to means selected to achieve the end. There are two qualitatively different deliberation processes and both of them necessarily require ethical thinking. Since ethics is a branch of philosophy, we can conclude that cybernetics may probably require more philosophical support than Science, which has no ethical issues regarding its end because it is to discover, find or identify the "truth". The difference among scientists is usually related to the kind of truth they are looking for as well as the kind of method to be used or, at worst, the method that should be used. So the ethical dimension in Science is almost reduced to scientific misconduct; which, in turn, is frequently pre-defined by academic elites along with publishers-based standards in publishing ethics and peer-reviewing. Scientific ethics is more frequently related to scientific practice than with the selection of what should be a scientific telos or a scientific end. Furthermore, the method is frequently pre-chosen according to the respective scientific discipline, or sub-discipline, or sub-sub-discipline. So it is evident that there are fewer selections to make than in the case of cybernetics. Consequently, *Cybernetics needs, with increasing urgency, an explicit ethical dimension; which, in turn, is better understood in the context of a philosophy, a* **Cybernetics Philosophy.**

This means that practice in Cybernetics necessarily requires an understanding of the ethical dimension. Understanding cybernetic phenomena as a whole, evidently, requires the support of philosophy. This is almost a necessary condition, though not a sufficient one. This is especially true if understanding this phenomenon is not an end in itself but among the means required in academic or professional practice and effectiveness.

In cybernetics, moral and ethical issues are at both levels: the "ends" and the "means" levels. The more complex is the cybernetic system, the more necessary are moral and ethical reflections in the deliberation (or the practical knowing) process. The simpler the cybernetic systems, the fewer the ethical reflections are required. Let us use extreme examples to convey what we are trying to express. Identifying an effective feedback mechanism for toilet tanks is an amoral activity. No other human being is affected, so no other consent is required. But, to find feedback mechanisms to feed back to the designer, or to other not related persons, private health data has

enormous moral issues involved. It is even worse if a cybernetician or a computer engineer or scientists create acceptable means for unacceptable ends, as for example, voting machines that allow the political user to cause fraud by means of enabling her/him to remove any kind of evidence. Is this ethical? Is it moral? How about surveillance, via chips placed under the skin, to track and to surveil the movement of people while providing the excuse that it is oriented to track people with COVID? Is this ethical? Is this morally acceptable?[70]

The main change in Science, as related to Systems Science and Philosophy, is the re-emergence of the notion of Teleology, and especially the Singer-Churchman "pragmatic-teleological Truth (Churchman, 1971) which is related to the effectiveness in achieving the telos, goal, objective, purpose of the respective thinker and/or doer.

10. Special Acknowledgement

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[70] In general, the problem of scientists' ethics is a huge one. How many scientists had ethical education? Can we reduce Ethics in Science to mere standards? Should ethical education be a necessary condition especially in the case of medical, biological, social, etc, sciences? Is it acceptable to kill at least 3.4 millions of people because it is advisable to take the risk of financing research oriented to **"Gain-of-function experiments"?** A much known "scientist" declared to the Australian press in 2012 that in some situation it is good to take this risk? If this is so, then you should take the decision? Is it all right for a scientist or a board of scientists to make this decision? A laboratory dedicated to civil and military research? We are not ignoring, here, the huge problem we have with regards of the lack of Ethos in many scientists and the lack of ethical education in the sciences. What we are trying to emphasize is that ethical education is even more important in Cybernetics because 1) it is related to the ends and the means and 2) its pan-cybernetic nature, i.e., Cybernetics is everywhere, even out of the realm of the sciences.

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End Notes

[i] In the set of "users and their managers" we are including different kinds of users and managers, i.e. those related to 1) the information systems being developed, 2) the methodological information system being used, 3) the organizational information systems in which the developing team is included, and 4) the organization in which the information is being developed and where it will be used. This is necessary from a systemic perspective, with which, each information systems is related to an environmental information system and this relation should be taken into account. Otherwise the developed system may not be legally, ethically or pragmatically feasible or desirable. Some objectives of actors in the environments might be restrictions that if not are taken into account the operation the system might not be feasible or its effectiveness might be lowers than what is desirable. Some objectives of some stakeholders may also generate restrictions to the development team, who should take then into account in order to ***avoid falling in the trap of confusing what is desirable with what is feasible***. In our experience, this has been the most frequent source of failing in software development.

[ii] I completely agree with Thomas Marlowe (Guest Editor) with his affirmation that the key ideas of the Agile Methods "have been adopted or incorporated in most software shops, reinforcing (in my opinion) the cybernetic and systemic nature of software development. [And I strongly believe that there are two good reasons why we still don't see improvement in 'successful': the one, because not everyone is doing it right, and the other, because as we make the process better, the more is demanded from the process.]" But I think there are more reasons: the problem is not just a technical also a non-technical one. Based on my own experience, I strongly belief that an updated Ethos, Pathos and Logos are also required. The ethical issue, as well as the emotional and empathic issues cannot be avoided. Like it or not Ethos and Pathos provide the bases for any human communication and Software development necessarily require an adequate human communication. The latter also requires managing the Logos used by the users and their manger. Technical Logos is necessary but not sufficient.

[iii] The following is a joke related by Stafford Beer (October 2001), regarding the difficulty of defining "Cybernetics" and the huge number of definitions that may be found

> "...it concerns three men who are about to be executed. The prison governor calls them to his office, and explains that each will be granted a last request. The first one confesses that he has led a sinful life, and would like to see a priest. The governor says he thinks he can arrange that. And the second man? The second man explains that he is a professor of cybernetics. His last request is to deliver a final and definitive answer to the question: what is cybernetics? The governor accedes to this request also. And the third man? Well, he is a doctoral student of the professor -- his request is to be executed second."

[iv] Let us remember, here, what Ludwig Wittgenstein called "language-game", i.e., a word or a phrase has the meaning of the "language-game" being played, its meaning depends on the rules of the game, as it is the case of war games, sport games, etc. Consequently, we need to emphasize that, in this article, we are using the phrase *"the whole is more than the sum of its parts"* in the context of the word-game played in Systems Philosophy and Cybernetics" or, more specifically in the context of Holism.

We are using, in this article the phrase *"the whole is more than the sum of its parts"* in its general sense, not in any specific sense, unless we refer to more specific, technical and precise sense of his phrase. This means that unless we explicitly refer to a more precise sense, this phrase will be used in the context of holism, as used in Krippendorff's (1986) Dictionay of Cyberentics. In this dictionary, Holism is understood, according to (Krippendorff, 1986, pp. 35-36) in his book "Dictionary of Cybernetics"

"A philosophical position claiming (a) that WHOLEs cannot be taken apart (->ANALYSIS) and (b) that every apparent whole can be understood only in the CONTEXT of the larger whole containing it. This belief is epitomized in the statement that *"a whole is more than the sum of its parts"* (->SYNERGY, ->ORGANIZATION). Although the position has merits, the infinite regression implied in the two-headed claim leads the wholist to believe in a hierarchical organization of the world (->HIERARCHY, -> GENERAL SYSTEMS THEORY). To understand anything requires him to explore larger and larger contexts, to seek refuge in increasingly universalistic kinds of understandings which renders him unable to simultaneously understand and cope with the particulars of a situation he started out with." (Krippendorff, 1986, pp. 35-36) [Italics and emphasis added]

But, frequently, the phrase *"the whole is more than the sum of its parts"* has been attributed to Aristotle. This is not correct. At least, two times Aristotle used a similar phrase. These were as follows:

"In the case of all things which have several parts and in which *the totality is not, as it were, a mere heap, but the whole is something beside the parts, there is a cause*; for even in bodies contact is the cause of unity in some cases, and in others viscosity or some other such quality. And a definition is a set of words which is one not by being connected together, like the Iliad, but by *dealing with one object*." Aristotle (Metaphysics, Book VIII, part 6., 350 BC)*,* [Italics and emphasis added]

"To return to the difficulty which has been stated with respect both to definitions and to numbers, what is the cause of their unity? **In the case of all things which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something beside the parts**, there is a cause; for even in bodies contact is the cause of unity in some cases, and in others viscosity or some other such quality. And a definition is a set of words which is one not by being connected together, like the Iliad, but by dealing with one object.-What then, is it that makes man one; why is he one and not many, e.g. animal + biped, especially if there are, as some say, an animal-itself and a biped-itself? Why are not those Forms themselves the man, so that men would exist by participation not in man, nor in-one Form, but in two, animal and biped, and in general man would be not one but more than one thing, animal and biped?

"Suppose, e.g., justice to be defined as temperance and courage. For if two persons each has one of the two only, both and yet neither will be just; for both together have justice and yet each singly fails to have it. Even the situation here described does not so far appear very absurd because of the occurrence of this kind of things in other cases also … yet at least that they should have contrary attributes surely seems quite absurd; and yet this will follow if the one is temperate and cowardly, and the other brave and profligate; for then both will exhibit justice and injustice; for justice is temperance and bravery, the injustice will be cowardice and profligacy. In general, too, all the ways of showing that whole is not **that the whole is not the same as the sum of its parts** are useful in meeting the type just described; for a man who defines in this way seems to assert that the parts are the same as the whole. *The arguments are particularly appropriate in cases where the process of putting the parts together is obvious, as in a house and other things of that sort: for there, clearly, you may have the parts and yet not have the whole, so that parts and whole cannot be the same."* (Sager, 2000, p. 70) *also in* (Aristotle, Complete Works of Aristotle - Vol. 1, 1984) [Italics and emphasis added]

It is good to notice that in none of the two texts above Aristotle use the phrase "the whole is more than the sum of its parts". And the context is "definition", in both cases. Aristotle refers (at least in

the two texts above) to **definition of objects not definition of words**. He refers to physical objects in the first text and to a conceptual object in the second. He does not relate definitions to words but to objects which are wholes of parts, not mere heaps.

Aristotle wrote *"the whole is something beside the parts"* and *"the whole is not the same as the sum of its parts"*, but, as long as we know, Aristotle never wrote what has been attributed to him, i.e., the whole is bigger than the sum of its parts. But, both Aristotelian senses still apply to what in the systems Approach and in Complex Systems is called emergent properties. Consequently, we can still suggest and, even, affirm, that Systems Philosophy and Cybernetics are re-discovering what has been in the texts for at least 2300 years. The difference is that this time there are empirical evidences of what has been conceived many years ago. We certainly can take this as empirical evidence as to philosophy is useful not just for understanding but also for doing. Its value is not just an intellectual one but also a pragmatic one. This is main focus of this article. This has been our experience for at least 40 years and this is why we are trying to convey it by means of showing evidence of it.

[v] We received the following comment,

> "Wholes that are greater than the sum of their parts" makes me think of "spaces that are larger inside than they are on the outside", with some sort of fractal "the parts encompass more than the whole." I'm going to leave it there, because this really needs some more thought."

This comment is an intellectually productive trigger for more reflections regarding this issue. Right now, we can start addressing it with the following text provided by Peter Fryer and Jules Ruis in the web site of "Fractal.org (Centre for Fractal Design and Consultancy)"

> "Within science, we introduce 'fractality' as a watchword for a new way of thinking about the collective behavior of many basic but interacting units, be they atoms, molecules, neurons, or bits within a computer. To be more precise, our definition is that fractality is the study of the behavior of macroscopic collections of such units that are endowed with the potential to evolve in time. Their interactions lead to coherent collective phenomena, so-called *emergent properties* that can be described only at higher levels than those of the individual units. In this sense, *the whole is more than the sum of its components*. (Fryer & Ruis, 2004) [Italics and emphasis added]

Consequently, at least for these authors, there seem to be no conflicts between fractals and "the whole is more than the sum of its components". On the contrary, fractals seems to confirm the production **of *emergent properties in the context of holism,* and *"the whole is more than the sum of its components"***

Now, we would like to make a comment and then a wild speculation, including some questions regarding the notion of "part" and the different senses it has, or may have.

There are two meaning of participation: "participating in" and "participating for". Let us use a metaphor to explain the difference: one thing is to participate in making a cake and another is participating in eating the cake. One think is "to take part of" and another is to "take part for". In the later case the whole is generated by the participation of the parts and in the second case the whole disappear as consequence of taking parts of it. So, evidently, the word "part" has different senses in the two linguistic contexts in which it is used. So, this is a very good example about what is very well known, i.e., the meaning of the word depends on the linguistic context it is being used, or, in Wittgenstein's terms it depends on the linguistic-game being "played".

Now let us make some specific questions before suggesting a wild speculation: Is a sub-system *part* of the supra-system where it is included? If yes, then can a part be a system? If the answer is yes, then every system is part of itself. Does this make any sense? If the answer is yes, then the notion of "part" would have at least two senses: single part and a set of related parts, i.e. a system. If this is so, the notion of part would be a genre in which the notion of system is among its species. Does this make any sense? This is the kind of situation we can get ourselves in when using words with no context. It is the context what provides meaning to a word, or a phrase. So changing the context may change its meaning. For example, the context in which Aristotle uses the word "part" is while ***defining an object.*** Anywhere else would not be in the same sense Aristotle used it.

The above paragraph provide us context for meta-commenting on the above comment that we received; which achieved its objective with regards to generating some (at least initial) thoughts. I suggest the following: In Wittgenstein's perspective, the comment above would be changing "language-game" for the same words and phrase. This may happen if we change the domain from a conceptual one to a subset of the Euclidean space, by means of generating *infinite* patterns that are self-similar across different scales. In this way we can generate infinite reiterations of self-similarities across different scales. This generates infinite self-similarities in the context of a Euclidean Space. Is this a new sense of "part", in the context of self-similar Euclidean Space generated via reiteration in different scales? Is so, then we are in a different Wittgenstein's linguistic-game and, consequently, words and phrases do not have the same meaning. Consequently, we cannot equate them without taking the risk of generating paradoxes, contradictions, confusions, miscommunications, etc. If we add new notion as interior and exterior applicable just to Euclidean Spaces, then we certainly may add similar kind miscommunication and their respective consequences. This may happen even in internal communication in the context of the same person.

In my opinion, if we accept Fryer and Ruis text, copied above, then fractals are a way to improve our understanding (via Lonerganian insight) of Leibnitz Monadology and its equivalent Theological notion of our participation in Gog and God participating in each one of us. It is really intellectually beautiful this cybernetic relationships between God and its Creation, which is analogical to relationships between artists and their created art, as well as between intellectuals and their writing. An artist is recreated by its own creation, as one writer wrote. Analogically, an intellectual would be recreated as consequence of her/his writing. I am personally sure that many intellectuals can confirm this kind of cybernetic relationships between them and what they write. They are in each part of the whole they wrote and each of these parts contains, though, partially its creator. Are all of these wild speculations not appropriate in a scholarly article? To be convinced, I need to have at least one example of Episteme not implicitly or tacitly base in a doxa. Is there any example? Is there any theorem not having been proved using unproven axioms? We may ask David Hume if there is any Empirical Science not based on a non-empirical supposition that the future would be like the past, Do any scientist have any window to the future? This seems to be self-evident. If so, why knowledge and opinion should be separated or shown as separated when the reality is that there is not knowledge not based opinion nor vice versa. They should be differentiated but not separated. They should be differentiated in order to more adequately relate them. If these relationships are cybernetic ones then we would have opened the possibilities and the potential of generating synergies and emergent properties, to be shared by both: knowledge or opinion and/or to increase the probabilities of generating Lonerganian insight that would deepen and/or enhance out understanding.

vi Thomas Marlowe (Guest Editor) commented (regarding Religious people) " Meditation and processes to induce meditation can certainly be thought of as homeostatic, whether the control signal is coming from an internal state, a higher-order being, or a 'universal spirit'. I agree with this suggestion and would add that. Based on what we described in section 6.2, there might be an emergent property generated by the religious collectivity where the whole have cybernetic relationships with its parts, while depending on them. Using a below described term: religion

"sublates" the religious individuals, i.e., is based and depend on them. We are referring her to the Lonerganian sense of "sublation", not its Hegelian sense. The difference between these two senses are briefly described in sections 6.2
.

We should add that there are other cybernetic descriptions of the phenomena related to "religion" and "religious person". But the most intellectually evident and with real life analogies is that the cybernetic relationships between the religious people and religions would be via emergent properties. **Metaphorically**, we can think about the ants' trail, which is an emergent property of the ant colony that allows the existence to the ants as a collectivity and as individual ants. It is important to notice here that we are referring here to an **expressive metaphor** not to a potential analogy.

vii Is there any "Scientific Method"? Scientific method**s** are what exist, up to our knowledge; or a Scientific Methodology, i.e., a set of related or relatable methods which may intersect each other. This set may be a fuzzy set, but, in any case it is a set of scientific methods. This is especially true because Science has several disciplines, and a larger number of sub-disciplines, let alone sub-sub-sub-disciplines. All this is consequence of the analytical emphasis in Science which is great! What is not great is to confuse the effectiveness of a method in a given discipline or sub-disipline with its potential effectiveness in other disciplines. What is wrong is to reduce intellectual rigor to the rigor required in a given discipline. This attitude tends to corrupts Science as whole, because the effectiveness of a given method is related to a discipline and as soon as you enforce its application in other disciplines, you are corrupting not just the method but the disciplines in which it is being mistakenly applied. What is it even worst is to predicate from the genre what can be predicated just from one of its species. This is non-sense and non-sense may generate more non-senses and, consequently, misunderstanding, confusion, and even unintentional intellectual corruption. On the other hand, it is good to remember that scientific rigor is just one on the many intellectual rigors that human being may produce. As Thomas Marlowe reminds us "both scientists and those in the formal sciences [mathematics, theoretical and formal computer science, and logics] would agree that the methods of the formal sciences, while at least equally rigorous, *do not use the scientific method*." We may add this alert to the rigor of other intellectual productions. So, for the same reason we should not reduced scientific rigor to what is called the "Scientific Method". So, the "Scientific Method" is wrong as a phrase, because there are many "scientific methods", even in the empirical science, there is NO SCIENTIFIC METHOD, but METHODS. Darwin, Einstein, Freud, etc. did not follow the experimental method but no one doubt that their work is a scientific one with the required intellectual rigor. This is why I personally am convinced that to reduce scientific methodology to one of its disciplinary methods is not just non-scientific attitude but even an unintentionally anti-science one. ***Awareness about the plurality of scientific methods allows for cybernetic relationships among them and, hence, opens the potentiality of scientific synergies, which may also be part of cybernetic relationships with other intellectual productions, hence generating intellectual synergies.*** The latter may, in Lonerganian terms, increase the potentially of insights; which can move us from experience to understanding, deepening and/or amplifying our previous understanding.

viii M. Joseph Sirgy included the following abstract in his paper (Self-cybernetics: Toward an integrated model of self-concept processes, 1990):

> "An attempt is made in this paper to develop a self-cybernetic model of human behavior, explaining behavior in terms of self-concept and cybernetics. The integrated model is essentially a self-cybernetic system described as a cyclical process involving monitor, input, comparator, and output processes. The monitor component is described in terms of self-monitoring; input component is described in terms of self-perception; comparator component is described in terms of self-evaluation; and the output of the self-cybernetic system is described in terms of three psychological processes—behavior change, cognitive change, and information search. It is argued that a self-cybernetic system can be

analyzed as a series of self-cybernetics cycles in time (t—1, t, t+1,…, t+n). Each self-cybernetic cycle starts out with a self-monitoring process that guides the person to monitor certain self-related information from the environment and/or activates certain self-expectancies from memory. The input serves to categorize the information as similar/dissimilar to self-expectancies evoked from memory. Information that is self-debasing attributed to the self and/or inconsistent with the evoked self-expectancy produces a stress signal forcing the individual to take corrective action through (1) cognitive change, (2) behavior change, (3) information search, or (4) a comparator operation. Cognitive change essentially involves employing one of the following three coping strategies: (1) self-concept differentiation, (2) self-concept compartmentalization, or (3) self-concept change. Behavior change involves decision making to engage in a course of action to reduce stress. Information search involves entering into an information search cybernetic cycle having its own monitor, input, comparator, and output functions. A comparator operation involves a self-evaluation in which self-perception (input) is evaluated in relation to a self-expectancy (referent). Unfavorable self-evaluations produce a stress signal which induces the person to engage in an output-related operation—cognitive change, behavior change, or information search." (Sirgy, 1990, Abstract)

Notice that what M. Joseph Sirgy call Self-Cybernetics is cybernetic support, which he describes (self-cybernetic system described as a "cyclical process involving monitor, input, comparator, and output processes" in order "to develop a self-cybernetic ***model*** of human behavior, explaining behavior in terms of self-concept and cybernetics" `[italics and emphasis added]