Philosophy and Cybernetics: Questions and Issues

Thomas Marlowe[1] and Fr. Joseph R. Laracy[1,2]

[1]*Department of Mathematics and Computer Science*
[2]*Department of Systematic Theology*

Seton Hall University

thomas.marlowe@shu.edu
joseph.laracy@shu.edu

Abstract

In this article, we consider some of the more interesting interactions of philosophy and cybernetics, some philosophical issues arising in cybernetic systems, and some questions in philosophy. Many of these are fruitfully explored in the articles in this issue, which are referenced where appropriate.[1]

1. Introduction

Cybernetics is, in a broad sense, the study of systems, controls or influences, and feedback. Cybernetics as an explicit field of study has been since its inception a fundamentally interdisciplinary discipline with deep roots on the one hand in applications in physics, engineering, management science, economics, and sociology, and on the other, in conceptual areas including philosophy and mathematics (von Foerster & Ashby, 1964; von Glasersfeld, 1995; Wiener, 1965). The precise definition of cybernetics is not at all clear; in fact, cybernetics has a cluster of definitions with substantial differences, but nonetheless overlapping, and for that reason [Callaos, 2021][2] refers to cybernetics as a "notion" rather than a precise "concept."

Nonetheless, there is reasonable agreement on the basic examples of cybernetic systems. Such systems range from a heating/cooling system with its thermostat, to (in principle) the global economy. Cybernetic systems are often divided into at least two groups. In first-order [FOC] systems (Figure 1), the controls are (typically) fully specified, external (environmental) influences are well-understood and often limited, and the focus is on the observed system and the actions of its controller. Most often, the goal of the system is well-specified (and slowly changing if at all), and actions are driven by the mismatch of system state and the goal.

[1] The authors wish to thank Dr. Mark Couch for technical editing of this article.
[2] This article necessarily refers to other papers in this Philosophy and Cybernetics special issue, which are listed separately in the references. For clarity, we will use brackets [ ] in referring to these articles, while all others will be references with parentheses ( ). This may on occasion result in instances of parallel lists of citations.

With a simple goal, the structure of Figure 1 suffices. More generally, the goal may not be easily metrizable, so that the goal must be encoded in the system, and measures and analyses are needed for goal matching. System rules may then need to change to correspond to changes in the goal, to poor fits between desired and actual control actions or resulting effects, or to weaknesses in the pattern matching process. (See Figure 2.)

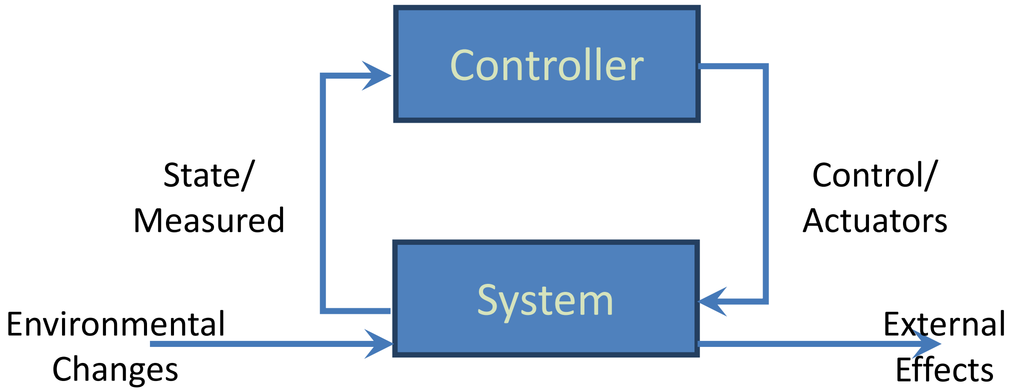

Figure 1.
A simple First Order Cybernetic [FOC] System.

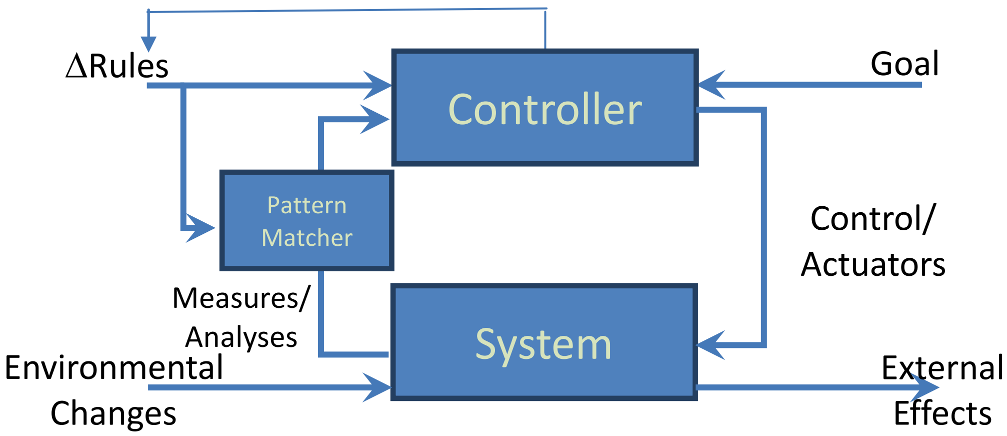

Figure 2.
A generalized FOC system.

Even Figure 2 is somewhat simplified, lacking edges from ‘External Effects’ to ‘ΔRules,’ and the possibility of modifying the ‘Goal,’ or the possibility of modifying the measures and analyses used as input to the pattern matcher.

In second-order [SOC] systems, the focus is on the observing—the interaction between the (often human) controller and the (often social) system. Interactions can be more complex and sometimes implicit, environmental influences can be broader, the goal may not be as well-specified or even well-understood, and the entire ecology is likely to be more subject to change. A key feature of SOC systems is *reflection* (on the state of the system and ecology) and *reflexion* (on internal state) by the controller/observer. (Note that some level of *reflection* can already be seen in FOC systems, in the rule modification in Figure 2.) Figure 3 is a simplified view of an SOC system with a human observer.

In (Marlowe et al, 2021), we suggest a transitional order [TOC], with characteristics of an SOC system, but with a controller/observer with only limited capacity for reflection and especially reflexion, particularly an artificially intelligent controller. We also consider implicit cybernetic systems, in which a (typically but not always SOC) system can be reconstructed *a posteriori*, and in particular examples in the arts, in which the observer interacts, not with the actual work, but with an internal copy or projection, as in reader-response theory [see also Nikolarea 2021]. Others [Jakubik, 2021; Minati, 2021] suggest additional classifications or orders of cybernetic systems. Precursors and harbingers of cybernetics on both sides, practical and conceptual, have been seen in antiquity and medieval times such as in the Greek notion of *telos*, in Kant and other philosophers [Burmeister, 2021; Horne, 2021; Laracy 2021]. An especially important modern philosopher is Bernard Lonergan [Callaos, 2021] (Laracy et al., 2019). The characteristics of cybernetics are intertwined, and questions in one category will naturally overlap with others.

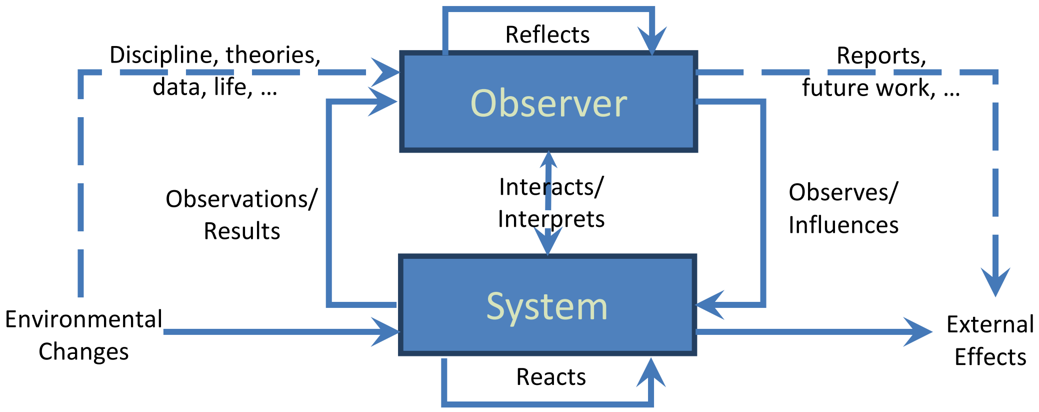

Figure 3.
An SOC system with human observer and observed group.

Note on terminology
We shall be using ‘system’ to refer to the system being controlled or under investigation/observation and ‘observer’ (and for FOC systems, sometimes ‘controller’) for the other side. External factors will constitute the ‘environment,’ no matter their kind—natural, social, legal and governmental, and so on. (However, ‘system’ will often be used in a more general meaning in ‘FOC system’ or ‘SOC system’.) The observer influences the system explicitly via ‘actions’ and ‘signals’; the system undertakes ‘actions’ (overloaded, but clear from context) and provides

measurable ‘responses’; in addition, each side influences the other through ‘communications’ and ‘interactions.’ The choice of observer signal or action, and the system response to such a signal, occur through consultation of a ‘rule base,’ which may be implemented mechatronically, or encoded in a database, program, or document, or exist purely in the mind of the observer, and may in each case involve a certain degree of variation or randomness.

The entire package—system, observer, environment, signals, actions, responses, communications, interactions, and the environment and changes in it—constitutes the ‘ecology’. In discussing design or implementation, ‘application’ may be used as comprising the system, the observer, and the rule base for signals or actions. An ‘implicit cybernetic system,’ as mentioned above, is one in which either the observer (or the ‘programmer’ of the observer) is not aware of the cybernetic nature of interaction (as in teaching), or one in which the system is not tangible, or measurement or the rule base is implicit. In addition, applications in which no conscious observer or programmer have been involved (such as global climate), if considered cybernetic, must clearly be implicit.

Finally, it is possible for cybernetic systems to interact in multiple ways. One simple example of hierarchical interaction (Figure 4) is an extension of the home thermostat FOC system (the dotted box), in which a resident can control the settings of the thermostat, in response to changes in environmental factors, such as humidity, or in individual circumstances, such as illness. Other modes are possible (Marlowe et al, 2021), including but not limited to cooperation, conditional alternation, or conflict. Some of these issues were identified earlier—see (Luhmann, 1986; Umpleby, 1997).

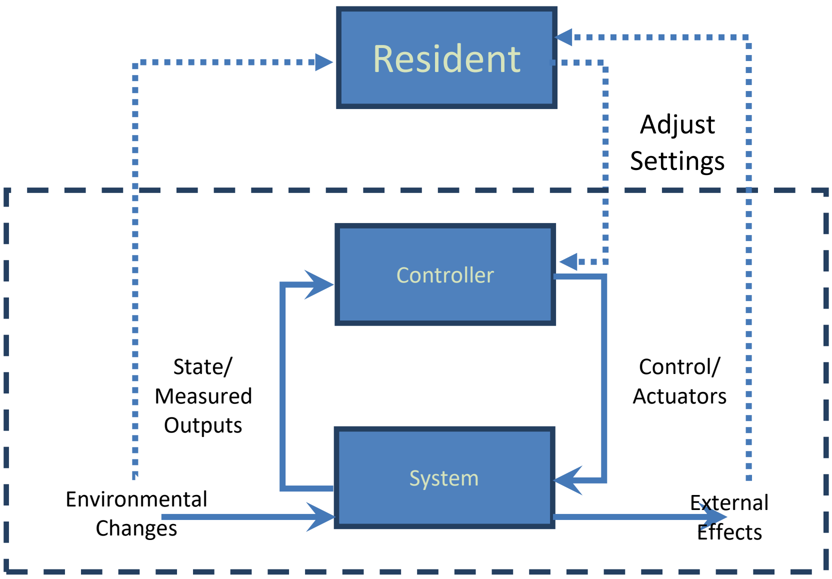

Figure 4.
A simple hierarchical cybernetic system.

In the rest of the paper, we look at some questions and issues that arise in considering the interaction of cybernetics and philosophy, focusing for the most part on those raised in the other contributions to this special issue. We identify six major themes: consciousness, intelligence, and the mind; epistemology, ontology, and metaphysics; ethics; social and political philosophy; teaching of philosophy and critical thinking; and general cybernetic systems.

Each of these sections comprises a list of questions, with additional discussion as appropriate. It is not always clear where to place a given topic or question, and the reader will find echoes and recurring themes across the sections.

2. Consciousness, Intelligence, and the Mind

We begin by considering some issues about the mind. The role of an intelligent agent in SOC and TOC systems is critical, both to the functioning of such systems, and to our understanding of them. Important questions are how that intelligence functions and how it is connected to an external universe, whether that intelligence or mind is necessarily human, and whether or how communities can act as the intelligence in such systems.

2.1. The mind, the world, and reflexion

We have observed that reflexion is key to SOC systems, and that the degree of reflexion often marks the boundary between SOC and human-mediated TOC systems, and is entirely (or almost entirely) absent in human-mediated FOC systems. The existence, nature, and boundaries of reflexion, and its relationship to concepts such as free will, sentience, wisdom, and for that matter reality, raise a number of questions of philosophical interest.

Free will is needed in passing from mechatronic FOC ecologies to SOC or most human-mediated FOC or TOC ecologies. At a minimum, its absence changes the discussion in critical ways. How does the absence or limitation of free will or autonomy change the philosophical understanding of these human-mediated cybernetic ecologies [Mabee, 2021] (Reynolds, 2021)? We note, in acknowledging this question, and both the philosophical and scientific issues surrounding free will, that we will otherwise assume some form of free will, at least in SOC and most TOC systems, for the balance of this article.

Is the interaction of the mind and the world an implicit SOC system? Or perhaps multiple systems, with interactions with both the actual physical environment, and with the internal copy, as mentioned above (Marlowe et al, 2021) [Nikolarea, 2021]?

What is the connection between *reflection* and *reflexion*, on the one hand, and the hierarchy of knowledge, understanding, and wisdom, on the other [Callaos, 2021] (Laracy et al., 2019)?

In discussions leading up to this article with Callaos, Horne, and others, and in other discussions in symposia at Seton Hall University, the following two apothegms emerged:

- "Wisdom is knowledge, informed by empathy/context and tempered by reflection."
- "Wisdom is the perfection/abstraction of knowledge."

Clearly, reflexion is part of consciousness/sentience, or at least of the awareness of consciousness and self. Should it be seen as the entirety of that awareness? If not, what characteristics particularize it and distinguish it from other aspects of that awareness? Perhaps it is best seen as a faculty combining that awareness, with evaluation (possibly along multiple axes), consideration of changes and strategies, and relation of self to the environment.

Is *reflexion* restricted to humans (at least on this planet)? Is it in part a learned behavior, or is it inherent in human nature, shared among all (barring the obvious cases, medical and otherwise)?

For those who advocate radical constructivism, second-order cybernetics can be seen as entailing a subjective or socially-constructed reality. This may extend, in an SOC ecology with multiple observers or observer groups, to multiple interacting and/or competing realities. (Compare [Jakubic, 2021; Makhachashvili, 2021].) Ought this extend to all potential SOC ecologies? How might this affect the understanding of the interaction of philosophy and cybernetics?

2.2. Artificial and animal intelligence

An ongoing question in cybernetics is the relationship of artificial intelligence, and other non-human intelligence, to cybernetics. While interest in artificial intelligence has gone in cycles from high to low over the past 70 years, it is currently intense, and with data analytics and intelligent devices, is likely to continue to be so. There is also a revived interest in animal intelligence. Examining the differences between human cognition, on the one hand, and artificial intelligence or animal cognition, on the other, leads to a number of important questions.

Artificial intelligences (AIs) appear at present capable of reflection (pattern discovery, surprises, novelty, creation of music and art (Barbour, 1999; Jaki, 1989; Neapolitan & Jiang, 2018))? Will future AIs ever be capable of *reflexion* [Callaos, 2021; Jakubik, 2021; Velarde-Mayol, 2021] or able to act as the agent/observer in an SOC system?[3]

In the context of an SOC or TOC ecology, can artificial intelligence and data science techniques, including machine intelligence and machine learning, mimic human reasoning indistinguishable from an apparent SOC controller? Can an AI make the needed ethical and moral decisions [Jakubik, 2021; Velarde-Mayol, 2021]?

If not, can an AI nonetheless act as an observer in an SOC system? If not, is there a useful category of cybernetic systems sitting between FOC and SOC? If so, do such systems fall within the transitional order [TOC] suggested in (Marlowe et al, 2021), or is still another order or category needed?

If a human agent's interaction with a cybernetic system of human or at least sentient creatures, or of groups, is entirely mediated through artificial intelligence(s), can this still be considered an SOC system? What characteristics would the interaction/interface have to have to be considered as an SOC system? What is it if this is not so? Would this fit an hierarchical system (see Figure 4) with an FOC or TOC AI system and a higher-level human SOC system? If so, what level or sort of human involvement would be required?

Some animals—including the other great apes, cetaceans, octopuses and squids, grey parrots and corvids, and elephants—have at various times and diverse ways exhibited behaviors which some suggest demonstrates strategy, self-awareness, language, empathy, contextual memory, and what seems to be a sense of fairness, both for self and for others. For a survey, related work, and discussion of related philosophical issues, see (Andrews & Monsó, 2021); for discussion in this issue, see [Velarde-Mayol, 2021]. Is an animal capable of *reflexion*? If not now, could it be learned or inculcated?

2.3. Communities and communal "intelligence"

There continues to be interest in cybernetic systems in ecology and environmentalism, in the social sciences and social services, and in economics at diverse granularities. In many of these investigations, the best

[33] In his technical editing pass for this article, Couch asks, "Don't computers already have this, since they can reflect on and acquire information about their internal state?" We judge this an excellent question. But in general, both the acquisition and the reflection are undertaken or guided by programmed algorithms, and we would consider that this falls short of true reflexion. We do however also recognize that this becomes a trickier question when resulting conclusions and changes are mediated by pattern discovery and inference at ever greater remove from the underlying program.

fit for the observer may not be a single individual. We are thus led to the following considerations.

Do groups, organizations, or communities sometimes act as if they are conscious and intelligent beings [Horne, 2021; Nikolarea, 2021] (Hall, 2010; Luhmann, 1986; Nousala, 2021)? They clearly have a context—culture, ethos, ethic, standards, etc.—which changes over time, sometimes through what seems like *reflection* and perhaps even *reflexion*. If so, do they act as observers for FOC or SOC systems (Umpleby, 1997)?

Disregarding governments and associations exercising decisions through established processes, are these social adaptive systems always implicit?

With the same exception, are the goals of such systems always either tacit or driven by informal consensus, as in the formation of mores and tradition? What drives the process of change in such social systems, and what are the implications for social philosophy? Nousala (2021) suggests that community-driven adaptive systems—whether social communities, communities of interest, communities of practice, communities of knowledge, or expert communities—almost invariably have goals, perceptions, and actions mediated by a blend of tacit, implicit, and explicit concerns. If this is valid, what are the practical and philosophical implications?

3. Epistemology, Ontology, and Metaphysics

These are perhaps the most characteristic subdiscipline of philosophy: the quest for the nature of truth, reality, knowledge, and causality. These questions also interact with cybernetics in often complex ways. It has been suggested (Marlowe et al, 2019), although with reservations, that implicit cybernetic systems might be a unifying and controlling model, which leads to further intricacies, and a consideration similarities and differences with autopoietic and homeostatic natural systems. We consider some of these questions in this section, with pointers to their consideration in articles in this special issue and elsewhere.

The emphasis in this section is largely on second-order [SOC] and to some extent transitional-order [TOC] systems. While FOC systems are most often presented as implementations or applications of (interdisciplinary) science (plus technology, engineering, and mathematics, and perhaps economics), SOC systems have an inherently subjective element, relying to at least as great an extent on social science, and in some accounts are entirely subjective [Jakubik, 2021].

We note, as with the article as a whole, that there is substantial overlap and recurrence among subsections here, with the topics and groupings intended to support a conceptual flow.

3.1. Foundations

What is the nature, and what are the limits, of cybernetics itself?

Do the ontology and epistemology for SOC systems require grounding [Laracy, 2021], and if so, what approach (or approaches) will serve well? Does this also apply to FOC systems?

Does human knowledge by definition or by nature exceed cybernetics, namely, insofar as it consciously intuits natural forms and judges that beings exist [Laracy, 2021]?

Umpleby (1997) suggests that a goal of constructivist cybernetics is to establish tolerance in society by acknowledging that each person *constructs* his or her own reality on their *personal* basis of experience (Vaihinger, 1911), and therefore has no basis to impose one's views on another. Is this a rejection of the classical definition of truth as *adæquatio intellectus et rei*? Does radical constructivism permit objectivity? Can one still speak of the "reality of the universe" (Pham, 1995)? What are the implications of adopting such a view for a general philosophy of science?

Might the broad application of the notion of an "implicit cybernetic system" (Marlowe et al, 2021) be an overreach, especially when applied to systems without a (possibly indirect) intelligent director? Does it therefore manifest an erroneous tendency in cybernetics, to conflate nature and artifice [Laracy, 2021]? If so, can the concept be constrained so that it remains both valid and useful? Can autopoiesis and homeostasis (Hall, 2010; Luhmann, 1986) offer a useful bridge between cybernetic and natural systems?

Is it ever fruitful to use implicit cybernetic systems in describing natural systems or homeostatic processes? If so, is the resemblance essential, or as a model, or only as an analogy? Is it possible to categorize those that fall in each class, or in which the comparison is misleading or counterproductive? Further, which systems are better described as autopoietic, and which as cybernetic?

Moreover, is the concept of implicit cybernetic system still reasonable in dealing with cognitive science, learning, or communication, when the observer (influencer, controller) is a human or group of humans? If so, are there any restrictions? Again, where it is reasonable, should such an implicit system be seen as essential, as a model, or only as an analogy?

How can cybernetics properly understand its *analogy* between the dynamism of natural (or personal) orders and artificial cybernetic systems (with the former as the pre-existing and absolutely primary analogate) [Laracy, 2021]?

Dixon (2019) stresses the parallels between cybernetics and existentialism and claims coherence between primary concerns of the two fields. He also looks at their separate and joint influence on the arts. How significant is this linkage? Should it affect how cybernetics and existentialism are each viewed? Should it affect how modern philosophy, and the arts in the late 20^{th} and the 21^{st} century, are perceived and taught?

3.2. Learning and Cognitive Science

Beyond the foundational issues of cognition addressed above, cybernetics has a number of connections with teaching, learning, and thought as everyday activities. In this section, we look in particular at the value of a cybernetic view for these processes and activities.

In its origins, cybernetics included a focus on knowledge, cognition, observation, and the nervous system, with specific reference to epistemology and cognitive science (Umpleby, 1994). What contributions does the early history of cybernetics, especially in the transition from FOC to SOC, offer for these disciplines?

Is learning inherently a cybernetic activity? The learning activity (and thus the cybernetic system being controlled or observed) could be real, as in science labs. It could be conceptual, as in mathematics, though perhaps realizable through images or manipulatives. Or it could be an imagined mental copy, as in interaction with a work of art or literature, as discussed above.

Is teaching inherently a cybernetic activity? The observed system is the students, the controller/observer the instructor, with various possibilities for the control signals/actions. Ideally, it is a second-order system, with the students and teacher both interacting, undertaking reflection about the material (and the rest of their education and lives), and undergoing reflexion about their roles as learners.

Learning and artificial intelligence [Jakubik, 2021]. To what extent can AI systems be said to truly *learn*? Again, can they reflect upon what they’ve learned? Can they reflect on learning (*reflexion*)?

To what extent does the triple Bloom model (cognitive, affective, psychomotor) of learning and teaching (Bloom, 1994) and its revision (Anderson & Krathwohl, 2000) relate to different levels of cybernetic or cybernetic-like interaction, and increasing levels of reflection and reflexion? We can see that these are strongly tied to Lonergan's (Lonergan, 1992) and earlier levels of mental processing, and interaction.

The original (noun-based) Bloom cognitive taxonomy places 'synthesis' and 'evaluation' as the highest levels; the revised (verb-based) taxonomy removes 'synthesis' and has 'evaluate' and 'create' as the top, above a common underpinning of 'remember', 'understand', and 'apply'. Does SOC suggest that Callaos (Barton, 2007; Callaos, n.d.) has a point in retaining synthesis, and ranking it above or co-equal to evaluation and creation?

In part, this may depend on whether 'synthesis' is limited to a single discipline, or whether it involves integrating two or more disciplines that have already been understood, analyzed, and evaluated. It may even be that we need to distinguish two 'synthesis' activities. Especially in the latter case, to what extent is this an analog of an SOC system?

Louis Kauffman, in plenary presentations at WMSCI, characterized insight as a fixed point of a second-order cybernetic system. Does SOC have implications for the nature of insight, intuition, gestalt, and similar concepts? (Practitioners of SOC, definitely including Kauffman, would find this meta-use of 'insight' as at a minimum amusing.) Jakubik [2021], in her article in this special issue, offers an extended and thoughtful discussion of learning and learning theories, and the essential roles of cybernetics and philosophy for both theories and practice of learning.

The cybernetic perspective provides additional context and interpretation for language and communication. Makhachashvili and Semenist [2021] maintain that the existence and ubiquity of cyberspace similarly (or to an even greater extent) affects our sense of language, meaning, and even understanding of reality. Are these primarily details (or analogies), or is there in fact a significant interaction with the philosophy of language and communication? Further, are there important insights into cognitive processes and the philosophy of cognition coming from these perceived differences and changes brought about by cyberspace-mediated communication, expression, and mental organization?

3.3. Interdisciplinarity

Interdisciplinarity has been a concern of the field of cybernetics since its inception, lying at the heart of the cybernetic approach, and, if anything is of increasing interest. Further, it is held to be of growing importance in education and for life and work in the information/cyberspace age.

Interdisciplinarity relies on the integration of multiple disciplines and perspectives, which also lies at the heart of both FOC and SOC [Callaos, 2021; Horne, 2021; Jakubik, 2021] (Marlowe et al, 2021; Nousala, 2020). Philosophical questions often arise through a unification of issues arising in multiple disciplines, and/or of consideration of multiple perspectives. Finally, philosophy is often seen as seminal to the liberal arts and, perhaps in a different way, the sciences.

How strong is the parallelism? Does philosophy illuminate the relationship between cybernetics and interdisciplinarity [Horne, 2021]? Conversely, does consideration of explicit and implicit cybernetic relationships contribute to the role of interdisciplinarity in philosophy (Marlowe et al, 2021)?

How closely is systems thinking related to cybernetics, and analogously, systems philosophy to the philosophy of cybernetics [Burmeister, 2021; Callaos, 2021] (Gharajedaghi, 2011; Kirby, 2003; Senge, 2006; Sterman, 2016)? To what extent is interdisciplinarity and integration of perspectives a key to systems thinking?

Scientism often fails to adequately appreciate the value-dependence of the sciences as well as the institutional structures that sustain and perpetuate the sciences. How can these limitations be overcome with SOC? How well are scientism (and perhaps anti-scientism) refuted by philosophical and cybernetic considerations [Mabee, 2021]?

How might the SOC perspective enhance the study of the humanities and the arts in general, and drama translation and its theatrical performances in particular [Nikolarea 2021] (Dixon, 2019; Marlowe et al, 2021)? Does this have transitive implications for the role of arts in understanding human nature and cognition?

Consider the creation of a new discipline (such as computer science) or a named interdisciplinary field (such as data science) (Nousala, 2020). Can we characterize the ontological or epistemological preconditions, interactions, and consequences of such events, and if so, is it useful?

3.4. Philosophy of Science

Science is held to be an important means of exploring reality, causality, and truth, and of acquiring knowledge. Cybernetics can be seen as in part a scientific discipline, in part a tool for understanding many systems, and in part an approach for understanding the process of science itself. Each of these aspects is explored in several of the articles in this special issue. Here are some of the questions raised about the interaction of science, philosophy, and cybernetics.

Assuming that our perceptions provide a reasonable (or at least useful) approximation to reality, we may assume that science will provide models that on the whole are increasingly better approximations to the underlying reality. The practice of science would then be, broadly speaking, analogous to cartography. Social factors—including tenure and grants—would influence where the mappers explore; theories would influence both how far-off objects are perceived, and how those nearby are described and recorded. Finally, different philosophies of science, or different sciences with their diverse and distinct goals might correspond to different cartographic projections, and different foci could correspond to different map encodings—physical, political, weather, economic, and so on (Reynolds, 2021).

To what extent does cybernetics, FOC and/or SOC, provide a useful model for aspects of the philosophy of science [Laracy, 2021; Mabee, 2021]?

To what extent do philosophies of science provide a useful understanding for the nature, capabilities, structures, and limits of FOC systems (Jaki, 2002; Maritain, 1951; Relja, 2008; Wallace, 1996)?

How has dynamical systems theory, a mathematical foundation for cybernetics, influenced the philosophy of science (Hirsch et al., 2012; Holmes, 2010; Strogatz, 2015)?

To what extent do philosophies of science, both in natural and social sciences, provide a useful understanding of the nature of interactions in SOC systems?

Does consideration of homeostasis as a unifying principle of FOC and SOC systems [Callaos, 2021] contribute to a unified view of the physical, natural, and social sciences?

To what extent do the insights and practices of SOC and related approaches provide insight on the social dimensions and practice of science?

To what extent, if at all, is cybernetics relevant to philosophical logic and the philosophy of mathematics (Grenier, 1948)? What do the limits to knowledge results of Gödel, Turing, Heisenberg, and others (Jaki, 1966; Marlowe, 2017; Marlowe et al, 2021)) [Horne, 2021; Minati, 2021] have to say about cybernetics, other than to be useful as analogies? To what extent do the results of Arrow and others in utility theory relate to multi-dimensional goals and objectives for explicit SOC systems?

Can a humanistic, cybernetic approach to the sciences avoid certain problems that ultimately beset varieties of scientism (Jaki, 1986), e.g., relating to the role that various values often play in and around scientific work [Mabee, 2021]? How might G.K. Chesterton's insights as an "interpreter of science", as described by Jaki, further enhance Norbert Wiener's quest?

3.5. Metaphysical Issues

In the last part of this section, we return to the foundational themes of the first subsection. Here we look more immediately at the relationships between and among cybernetics, reality, and the mind.

While first-order cybernetics may emphasize only the apparent input-output relation between control actions and system state, and the response to the changes in the environment, second-order cybernetics has to deal with the internal state of the observer (and often of individuals or groups in the system, where these exist). Is an intellectual vision of the notion of *esse* in any sensible datum? Is the existence of a 'bridge' between the mind and external reality an axiom? Can we reach an 'intuition of being' through the apprehension of *ens secundum quod est ens*? (Gilson, 2011, 2012; Maritain, 1959) [Laracy, 2021].

Or must we establish a 'bridge' to establish the relationship of true reality to perceived reality—the noumenon to the phenomenon (Cheli, 2018; Kant, 2007; Liddy, 2020; von Glasersfeld, 1995) [Burmeister, 2021]? What is the relationship of individual mental models of that reality, as well as of interpersonal relationships, to one's everyday understanding and perception of the same?

To what extent is cybernetics, and in particular the work of von Foerster, helpful in advancing the Kantian approach, in providing a "constructivist and anti-reductionist" philosophy of mind [Burmeister, 2021]? Alternatively, does the cybernetic constructivist epistemology exacerbate problems first created by Kant [Laracy, 2021]?

Does cybernetics provide an appropriate unifying approach (or a significant part of an approach) for dealing with (broad categories of) change[4] [Minati, 2021]? Can a networked cybernetic system (Marlowe et al, 2021), perhaps entirely or largely implicit, sufficiently account for self-organization, emergence, and meta-structures? Can a (possibly implicit) cybernetic control system account, at least conceptually, for regions of validity/applicability, waves of complexity, and other higher-order phenomena [Minati, 2021]?

---

[4] In his technical editing pass for this article, Couch remarks, "There are many kinds of change. An apple turning brown is 'a change', but [does not form] a cybernetic system." We concur. Some types of change will not fit the cybernetic model, except perhaps as part of a much larger ecology. Clearly, further investigation is needed.

Is the proposal of Umpleby (1997), to examine social cybernetic ecologies (our terminology) from the four perspectives of variables, events, individuals and groups, and concepts/ideas, and the relationships of those perspectives, simply an analytical convenience, or does it add conceptual and philosophical richness?

4. Ethics

Cybernetic systems, from simple first-order systems such as thermostats, to complex second-order ecologies involving multiple interacting controllers and observers, have effects on humans, society, and the environment. In addition, the actions of controllers/influencers (or of their designers/controllers) may involve ethical choices, and affect and be affected by their ethical perspective. Even what and how they observe, as we have come to understand, is often related to privacy and rights, and reflexion is clearly related to judgment, often with a moral dimension. Finally, we have seen that cybernetics as an approach can (and perhaps must) interact with teaching and learning, and with the acquisition of knowledge, understanding, and wisdom, and thus once again with ethics.

In this section, we first examine cybernetics and the development of an ethical perspective, and then at ethical considerations in the design and use of cybernetic systems. It should be noted that the latter is not just limited to SOC and TOC ecologies—safety, privacy, and autonomy concerns can arise even in very simple FOC systems.

4.1. Development of Ethical Perspectives

Can (any) methods used to inculcate ethical behavior and understanding (particularly in children) be considered as cybernetic systems? Note there are multiple observers—parents, teachers, older peers, religion, literature, and more—some of which are influenced directly by the interaction, and some, such as children's literature, far more slowly and indirectly. There is also a massive environmental factor in changing social mores, as well as external influences from politics, theories of childhood development, and more, which in part represents reflection/reflexion and reciprocal influence.

Is a cybernetic approach useful in examining the justice/fairness-based ethical development model of Kohlberg (Damon, 1990; Kohlberg, 1981), from either a philosophical or practical view? In considering the non-hierarchical (and assertively feminist) ethics of care model (Gilligan, 1982)? Does considering ethical action and development as an SOC system offer any insight about the contrast, or suggest a synthesis?

Is the cybernetic approach useful in examining tolerance, acceptance of diversity, and open-mindedness (or the lack thereof)?

4.2. Ethics in the Design and Use of Cybernetic Systems

What are the ethical responsibilities of the cyberneticist in designing a complex system in careful design and implementation of the goal(s), the control actions, and the control logic [Callaos, 2021]? Hints may be found in the ACM/IEEE Software Engineering Code of Conduct (Gotterbarn, 1997) and other professional codes of conduct.

What are the ethical responsibilities of the cyberneticist in the design of an FOC system in which the system does not directly involve humans or sentient animals? These might involve guards against the inappropriate use of the system. For example, use of an FOC system to improperly or inappropriately control human beings. Even a thermostat controllable only by outside agents could be used to disorient or discomfort, rather than provide a comfortable or even tolerable environment. At the other extreme, problems in a critical FOC system—say, for nuclear power plant control—could have major effects on worker and public safety and health, the environment, and the economy.

What are the ethical responsibilities with respect to the information that the system generates about human beings and their choices? What safeguards should be in place related to privacy, confidentiality, intellectual property, etc.? Note that these questions find parallels in data analytics and in statistics.

Again, applying at least as much to statistics and data analytics, but also to information gathered from SOC and some FOC systems: While some individual information clearly should be protected, what are the responsibilities with respect to releasing aggregate information? What extra measures might be needed in releasing aggregate information about groups identified by protected characteristics? Conversely, what care is needed in qualifying aggregate information if the population sampled is not representative or sufficiently diverse? (This has arisen frequently in medical research, including research related to the current pandemic.)

Does the understanding that one is participating in an SOC system in a given role or roles change one’s professional responsibilities toward other participants, e.g., in software engineering or teaching? What changes if one is participating in overlapping systems, sometimes as observer, sometimes observed, sometimes environmental factor, and possibly sharing a role with others, e.g., teaching with administration, parents; constraints imposed from above such as unions with both positive and negative influences; social changes with largely good but some unexpected effects?

The Cynefin framework classifies problems as complicated, complex, or chaotic, depending on the nature of the difficulty (Schumann, 2012; Snowden, 2007). Complicated problems have many steps, with perhaps intricate relationships and dependences, but steps and relationships are individually understandable and solvable. Complex problems in contrast may have simple structure, but no clearly evident approaches, and will often involve emergent structures or properties. Finally, chaotic problems, while possibly solvable in principle, are unboundedly sensitive to initial conditions, or possibly non-deterministic in a non-trivial way. A problem that has all three characteristics is considered “disordered”, or incapable of solution.

Problems that are both complicated and complex have sometimes been termed “diabolical,” since the relationships of steps and implications of solutions have to be considered while attempting to solve an individual complex step. Climate change has been cited as an example (Manne, 2015) of a diabolical problem.

What ethical issues arise (to complement practical concerns) in deciding whether to implement a “diabolical” (that is, both complex and complicated) cybernetic system with artificially intelligent control vs human control? Note that neither practical nor ethical issues necessarily favor human control, and that a key practical and to some extent philosophical issue in a hybrid control scheme lies with the placement and nature of the boundary/interface and its encoding.

4.3. Bionics

In these two brief subsections, we look at three areas needing special consideration: bionics and cyber-physical systems, safety-critical systems, and the environment.

What constraints apply in the creation of cyber-physical systems? Which human functions can safely be delegated to cybernetic systems, and what degree of human control needs to be retained? Note that there are major positive advances in prosthetics, using eye movements or even brain signals as controllers, and so on. Do the ethics depend on the science, and if so, how do we acquire the knowledge and experience without ethical violation?

What about direct connections and interfaces in the brain? Downloading the brain? Life extension via cyber-physical support? If this direction is pursued, would it be helpful to model these as cybernetic systems in modeling constraints, interfaces, and so on?

4.4. Safety and the Environment

What cybernetic design principles should govern or influence the design of safety-critical systems (Laracy, 2017)?

What cybernetic design principles should govern or influence the design and use of autonomous vehicles? Would it help to think of and design these as AI-directed TOC systems?

What cybernetic design principles should govern or influence the design of systems whose poor implementation, mis-operation, or failure would have substantial environmental, sociopolitical, or economic risk (compare [Horne, 2021])?

5. Social and Political Philosophy

Once we consider cybernetic ecologies in which groups, organizations, or societies play a role, whether as the observed system, as the observer, or as external actors, or with mixed roles in a complex ecology, issues of social and political philosophy inevitably arise. In this section, we consider a number of these issues. We note that this section has significant overlap with Section 4 (Ethics) in particular, and other relevant questions will be found there.

Does cybernetics as a governance model reduce the general populace to the level of the 'ecology' to be controlled, which reacts without conscious intervention? Or does the populace also have/constitute a controller with its own rules/goals, as part of a complex and reciprocal cybernetic ecology (Reynolds, 2021)? How does the form and reality of governance or association affect this?

If we consider social and political communities as SOC ecologies in which both the observer and the observed are communities: How do we account for the tension between individual vs communal goals and controls, especially given Arrow's Impossibility Theorem (Arrow, 1950)? Arrow's Theorem basically says that it is impossible to always extract a communal social welfare function from individual welfare functions, given a reasonable and small set of properties [axioms] the extraction must follow. The theorem is often applied to voting, where there are approaches to bypass its constraints, but those approaches are much less applicable—and therefore unsuccessful—when dealing with competing economic and social objectives.

Does thinking of governance as a reciprocal cybernetic system shed useful light on social and political responsibilities and rights? Viewing this system as embedded and interacting with the physical world and human presence as an ecology (both in the cybernetic and scientific senses), does SOC add anything to the discussion of environmental and related issues?

Does considering governance as an SOC ecology aid in evaluating the technocratic paradigm? Inversely, does it say anything about resistance to scientific progress or legitimate systemic efforts such as contra-pandemic practices and vaccines? If so, what are the implications for the social and political philosophy?

6. Teaching of Philosophy and of Critical Thinking

In this section, we return once more to teaching and learning, this time with a focus on the role of cybernetics in teaching and learning, particularly in relation to the teaching of philosophy and critical thinking, and conversely, to the teaching of cybernetics as a discipline. We also look at the relation of cybernetics to agile software engineering.

Should the teaching of modern philosophy include cybernetics, particularly SOC, and if so, how, how much, and where? Is the distinction between *reflection* and *reflexion* worth making outside of cybernetics itself?

Is SOC a useful ingredient, tool, or model for the teaching of social and political philosophy?

Does the interdisciplinary and multi-perspectival nature of SOC say something useful about the value of disciplinary and social diversity in society and in the workplace?

Can cybernetics say anything about the history of philosophy, beyond either tracing a thread through its precursors [Callaos, 2021; Horne, 2021] or considering its explicit influences and parallels in the 20th and 21st centuries (Laracy, 2021) [Laracy, 2021]? Does tracing those precursors and parallels add anything to the teaching of philosophy, and if so, how should it be incorporated—as a module or thread in a History of Philosophy course, in a Philosophy of Science course, as (part of) a special topics course, other?

Conversely, how much does the study of the precursors of cybernetics in philosophy and other disciplines add to the study of cybernetics?

Does cybernetics, particularly SOC and interacting cybernetic systems, have a place in the teaching of critical thinking? In developing critical thinking, or only in explaining it?

Does cybernetics, particularly SOC, provide an avenue or bridge for exploration of epistemological, ethical, and other philosophical considerations for software engineering and agile software development, and for feedback systems in general? Would consideration of the philosophical (epistemological, ethical, cognitive) differences among approaches including Lonergan's GEM, Systems Philosophy, SOC, and agile software development be useful (Beards, 2011; Lonergan, 1990; Marlowe et al, 2020) [Callaos, 2021]?

7. General Cybernetic Systems

Finally, we consider a number of large-scale questions related to cybernetics and its generalizations, implicit cybernetic systems and interacting cybernetic ecologies.

Can cybernetics be considered as an organizational principle of "first philosophy"? If so, does it displace metaphysics or only complement it? Given the former, what are the consequences of doing so, as opposed to relying on the traditional foundation of metaphysics, whose formal object is the study of *ens qua ens*?

Does the interaction between philosophy and cybernetics form an implicit SOC system on its own (Marlowe et al, 2021)?

Is the concept of implicit cybernetic systems (Marlowe et al, 2021; Umpleby, 1997) a useful one in examining issues in philosophy, economics, literature and the arts, the natural sciences, and other disciplines?

Does the idea of interacting cybernetic networks—cascades and hierarchies, competition and collaboration, conflict, and other modes (including multi-goal system, minor clients, reciprocal influence, and various forms of selection) (Marlowe et al, 2021; Umpleby, 1997; see also Luhmann, 1986)—add value to (or remove value from) any of the above? How does realization of these complications change approaches or implementations?

8. Conclusions

We have presented an overview of some of the questions relating philosophy and cybernetics—the philosophy of cybernetics, cybernetics in philosophy, and analogies and parallels. The interaction appears to touch the major areas of philosophy—the nature of consciousness; epistemology, metaphysics, and cognitive science, including the philosophy of science; ethics and social, political and economic philosophy; and teaching and learning, including the teaching of philosophy.

Many of these questions are helpfully explored further in the special issue—although undoubtedly we have missed both some questions and some cross-references.

Acknowledgments

The authors wish to thank Dr. Mark Couch of the Department of Philosophy (Seton Hall University) for his perceptive comments, as well as for proofreading and technical editing. We would also like to thank the authors of articles in this special issue, especially Drs. Nagib Callaos, Jeremy Horne, John T. Laracy, Ziyuan Meng, Ekaterina Nikolarea, and Victor Velarde-Mayol, together with Susu Nousala and Eugene Reynolds, for extensive commentary and interaction in the inception and unfolding of this article. The authors also wish to acknowledge the influence of stimulating presentations and discussions in recent on-line symposia conducted by the Catholic Studies Program, the Center for Catholic Studies, the Chesterton Institute, and other organizations at Seton Hall University.

9. References

Articles from this Special Issue (listed in journal order, other than this one)

Laracy, John L. & Joseph R. Laracy (2021). *Reconceiving Cybernetics in Light of Thomistic Realism.*

Mabee, Zachary M. (2021). *Nascent Cybernetics, Humanism, and Some Scientistic Challenges.*

Burmeister, John M. & Ziyuan Meng (2021). *Kant, Cybernetics, and Cybersecurity: Integration and Secure Computation.*

Jakubik, Maria (2021). *Interplay between Cybernetics and Philosophy as an Essential Condition for Learning.*

Minati, Gianfranco (2021). *Towards a General Theory of Change: a cybernetic and philosophical understanding.*

Velarde-Mayol, Victor (2021). *Artificial Intelligence and Human Intellect.*

Horne, Jeremy (2021). *The Philosophy of Cybernetics.*

Nikolarea, Ekaterina (2021). *Cybernetics and Philosophy in a translation of Oedipus the King and its Performance.*

Makhachashvili, R. & Semenist, I. *Linguistic Philosophy of Cyberspace.*

Callaos, Nagib (2021). *Systems Philosophy and Cybernetics.*

External References

Anderson, L. W., & Krathwohl, D. (Eds.). (2000). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives.* Pearson.

Andrews, K., & Monsó, S. (2021). Animal Cognition. In E. N. Zalta (Ed.), *Stanford Encyclopedia of Philosophy*. https://plato.stanford.edu/archives/spr2021/entries/cognition-animal/

Arrow, K. J. (1950). A Difficulty in the Concept of Social Welfare. *Journal of Political Economy*, 58(4), 328–346.

Barbour, I. G. (1999). Neuroscience, Artificial Intelligence, and Human Nature. In R. J. Russell (Ed.), *Neuroscience and the Person: Scientific Perspectives on Divine Action* (249–280). Vatican Observatory.

Barton, J., & Haslett, T. (2007). Analysis, Synthesis, Systems Thinking & the Scientific Method: Rediscovering the Importance of Open Systems. *Systems Research and Behavioral Science*, 24, 143-155.

Beards, A. (2011). Generalized Empirical Method. *The Lonergan Review*, 3(1), 33–87.

Cheli, S. (2018). *Radical Constructivism: Historical Roots and Contemporary Debate*. SocArXiv. https://doi.org/10.31235/osf.io/69ne8

Dixon, S. (2019). *Cybernetic-Existentialism: Freedom, Systems, and Being-for-Others in Contemporary Arts and Performance*. Routledge.

Gharajedaghi, J. (2011). *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture* (3rd ed.). Elsevier.

Gilson, E. (2011). *Methodical Realism*. Ignatius Press.

Gilson, E. (2012). *Thomist Realism and the Critique of Knowledge* (M. A. Wauck, Trans.). Ignatius Press.

Grenier, H. (1948). *Thomistic Philosophy - Volume I: Logic and Philosophy of Nature* (O'Hanley, J.P.E., Trans.; Vol. 1). St. Dunstan's University Press.

Hall, W., Nousala, S. (2010). *Autopoiesis and Knowledge in Self-Sustaining Organizational Systems*, 4th International Multi-Conference on Society, Cybernetics and Informatics (IMSCI 2010). June 29 - July 2 – Orlando, Florida, USA.

Hirsch, M. W., Smale, S., & Devaney, R. L. (2012). *Differential Equations, Dynamical Systems, and an Introduction to Chaos* (3rd ed.). Academic Press.

Holmes, P. (2010). A Short History of Dynamical Systems Theory: 1885-2007. In V. Lundsgaard Hansen & J. Gray (Eds.), *History of Mathematics* (115–138). Eolss Publications.

Jaki, S. L. (1966). *The Relevance of Physics*. University Of Chicago Press.

Jaki, S. L. (1986). *Chesterton, A Seer of Science*. University of Illinois Press.

Jaki, S. L. (1989). *Brain, Mind and Computers*. Gateway Books.

Jaki, S. L. (2002). *A Mind's Matter: An Intellectual Autobiography*. Eerdmans.

Kant, I. (2007). *Critique of Pure Reason* (G. Banham, Ed.; N. K. Smith, Trans.; 2nd ed.). Macmillan And Company Limited.

Kirby, M. W. (2003). The Intellectual Journey of Russell Ackoff: From OR Apostle to OR Apostate. *Journal of the Operational Research Society*, 54(11), 1127–1140.

Laracy, J. R. (2017). A Systems-Theoretic Security Model for Large Scale, Complex Systems Applied to the US Air Transportation System. *International Journal of Communications, Network and System Sciences*, 10(5), 75–105.

Laracy, J. R. (2021). An Evaluation of Two Realist Philosophical Approaches for Rigorous Interdisciplinary Communication. *Journal of Systemics, Cybernetics, and Informatics*, 18(1), 184–196.

Laracy, J. R., Marlowe, T., Valdez, E., & Liddy, R. (2019). Cybernetics of Observing Systems and Lonergan's Generalized Empirical Method. *Journal of Systemics, Cybernetics, and Informatics*, 17(5), 65–70.

Liddy, R. (2020). Jaki and Lonergan: Confrontation or Encounter? In P. Haffner & J. R. Laracy (Eds.), Stanley *Jaki International Congress.* Gracewing Publishing.

Lonergan, B. (1990). *Method in Theology* (2nd ed.). University of Toronto Press, Scholarly Publishing Division.

Lonergan, B. (1992). *Insight: A Study of Human Understanding* (F. Crowe & R. Doran, Eds.; 5th ed., Vol. 3). University of Toronto Press, Scholarly Publishing Division.

Luhmann, N. (1986). Self-Organization and Autopoiesis. In M. B. N. Hansen & B. Clarke (Eds.), *Emergence and Embodiment: New Essays on Second-Order Systems Theory*, 143-156. Duke University Press Books.

Luhmann, N. (1995). The paradox of observing systems. In Rasch, W. (ed.) *Theories of Distinction: Redescribing the Descriptions of Modernity*. Stanford University Press, Stanford (2002), 79-93.

Maritain, J. (1951). *Philosophy of Nature* (I. C. Byrne, Trans.). Philosophical Library.

Maritain, J. (1959). *Distinguish to Unite, or, The Degrees of Knowledge* (G. Phelan, Trans.; 4th ed.). Charles Scribner and Sons.

Neapolitan, R. E., & Jiang, X. (2018). *Artificial Intelligence: With an Introduction to Machine Learning* (2nd ed.). CRC Press.

Nousala, S., Galindo, K.B., Romero, D., Feng, X., Aibeo, P. (2021). Systemic Preconditions and Ontological Modeling for Pre-Urban Communities. *Journal of Cultural Heritage Management and Sustainable Development*, 11 (3): 201-213.

Nousala, S., Marlowe, T.J. (2020). Interdisciplinary Fields as Ecological Communities. *Journal of Systemics, Cybernetics and Informatics*, 18 (1): 175-183.

Pham, J.-P. (1995). The Importance of The Reality of the Universe in the Work of Stanley L. Jaki. *Faith & Reason*, 21(4), 337–354.

Relja, H. (2008). *Il Realismo di S.L. Jaki: Dalla convinzione religiosa tramite il realismo moderato e la creatività scientifica fino al realismo metodico* [PhD]. Ateneo Pontificio Regina Apostolorum.

Reynolds, E. (2021). Personal communication.

Senge, P. M. (2006). *The Fifth Discipline: The Art & Practice of The Learning Organization.* Doubleday.

Sterman, J. D. (2016). *Business Dynamics*. McGraw-Hill.

Strogatz, S. H. (2015). *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*. Westview Press.

Umpleby, S. (1997). Cybernetics of Conceptual Systems. *Cybernetic Systems,* 28: 635-651.

Vaihinger, H. (1911). *Die Philosophie des Als Ob.* Reuther & Reichard.

von Foerster, H., & Ashby, W. R. (1964). Biological Computers. In K. E. Schaefer (Ed.), *Bioastronautics* (333–360). MacMillan and Co.

von Glasersfeld, E. (1995). *Radical Constructivism: A Way of Knowing and Learning.* Routledge.

Wallace, W. A. (1996). *The Modeling of Nature: The Philosophy of Science and the Philosophy of Nature in Synthesis.* The Catholic University of America Press.

Wiener, N. (1965). *Cybernetics, or Control and Communication in the Animal and the Machine* (2nd ed.). The MIT Press.