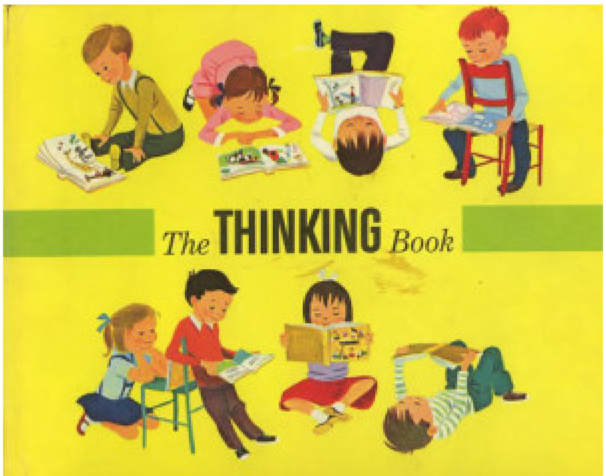
# IIDE Proceedings 2014 – Toward Post Systems Thinking In the Conception of Whole-Part Relations




Systems thinking represent a diverse intellectual body that aims to support conception of phenomena. Systems thinking may be regarded as a reaction against the micro-reductionism inherent within the modernist scientific approach; more specifically in the latter's conception of *whole-part relations*. While the propositions offered by systems thinking overcome that reductionism, we show that due to its biotic root-metaphor it instead imposes macro-reductionism. We proceed then by drawing on two alternative approaches that facilitate our conceptions of relations between a whole and its parts, in terms of *encaptic relations* and *assemblage relations*. A key conclusion advanced is that any utilization of analytical thinking and systems thinking must be conducted carefully and self-critically, due to their inherent limitations. As a consequence, this suggests an initiative for intellectual development of a post systems thinking approach, with regard to the conception of whole-part relations.

1. *Introduction*
We start this essay with an exposition of the micro-reductionism of modernist scientific thinking, called here analytical thinking. We then expose both the remedy offered by systems thinking and the macro-reductionism it imposes. We continue with our suggestion for a post systems thinking approach, where the whole-part relation is re-conceptualized to eliminate both micro-reductionism and macro-reductionism.**[iii]** This is done with the support of two rather different bodies of social ontology: Dooyeweerdian *encaptic* relations and DeLanda's notion of *assemblage* relations. Our overall aim is to direct a further development of the conception of the whole-part relations so that more justice can be done to our

experiences of the complexities of social affairs. The content of the paper follows the structure of the argument outlined; however it is also includes an illustrative case of the dramatic and tragic event of the Soviet submarine K-19, which we present in the remaining part of this Introduction.

1.1. *K-19*

As the end of World War II had produced major tension between western countries and the Soviet sphere states, the cold war was established. Both sides raced to produce the most sophisticated and threatening weapons with the aim of demotivating the other from any aggressive actions targeted at the other side. Perhaps the most sophisticated weapon developed during the cold war was the nuclear submarine. Such a sub utilizes nuclear technology in two ways; one is that it is capable of launching ballistic missiles from the ship, which is equipped with nuclear bombs. The second means that the ship is powered by its nuclear power station and is thus independent of re-fueling operations for years, which makes it much harder to detect and strike against. USA was the first country to develop and introduce nuclear submarines in its weaponry arsenal, which in turn created an imbalance, where Soviet perceived a major threat. This motivated Soviet to develop and launch its own nuclear submarine, the so-called 658 class of which K-19 was the first submarine introduced (Huchthausen, 2002).

On June 4th, 1961, while K-19 was on its maiden voyage conducting exercises outside southern Greenland, it developed a major leak in the reactor coolant system, causing the temperature to rise uncontrollably and putting the whole ship in a very dangerous situation – with no chance of external assistance … Faced with the choice of either abandoning ship or attempting its repair, the Captain First Rank *Nikolai Vladimirovich Zateyev* put together a team of eight crew members with the objective to implement a new cooling system and thereby prevent a disaster; this effort succeeded. Yet, the eight crewmen died of radiation exposure within a month and fifteen more died within two years (ibid.).

The recent release by Russian authorities (ibid.) of classified information about K-19 and its accident, has led to the 2002 film dramatization, entitled "K-19: *The Widowmaker*". In the early part of that film, we can see young men boarding K-19; some of them have to leave their fiancées and family members behind, and they promise to be back soon… One of these men is later chosen to participate in the special taskforce to repair the cooling system. We can follow this man's anxiety, desperation, refusal to cooperate and his finally being forced to do '*his duty for his mother country*' – the men died onboard.

Among many questions raised by this story, one concerns the man who did not want to die and therefore initially refused to join the special taskforce. Should we regard this man as a solider and as such under obligation to obey military rules, or should we regard him as being part of a family and as such entitled to refuse to be a part of the armed forces? Or should we regard this situation in another way?**[iv]**

2. *Analytical Thinking Versus Systems Thinking*

In this section we will expose so-called *analytical thinking*, including its key points, a brief application to the K-19 case, and reflections on its strengths and limitations. A similar account will then be given to the anti-pole of analytical thinking, so-called *systems thinking.*

2.1 *Analytical Thinking: the whole as an aggregate*

We expose *analytical thinking* to provide a *raison d'être* for the subsequent exposition of *systems thinking,* which is the subject of critical diagnosis in this essay. The concept called here *analytical thinking*, as suggested by Le Moigne (1999), may also be called *modernist science thinking* (Checkland 1981: Ch.2).

Following the origins of rational thinking and inquiry in ancient Greece and the medieval period, the scientific revolution of the 17th century has provided us with one of the greatest inventions of the Western Civilization: Science. Copernicus and Kepler established the heliocentric model of the solar system, Galileo developed much of its mechanics and Newton put together terrestrial and celestial dynamics. In all this, Whitehead (1925: 77) characterized *science* as: "*…educated men searching for the general principles which the scientists believe underpin the natural order*". While there is no final characterization of what science is or is not, and there do exist a number of excellent characterizations (Jeans, 1947; Singer, 1941), science is often associated with such terms as: invariance and general principles, scientific method and controlled observation, hypothesis, isolation, reduction, designed experiments, laboratory, documentation and reporting of tests, and repeatability. One of the key hallmarks of science was the establishment of the scientific method that specifies what needs to be done to produce and reproduce scientific knowledge, as distinct from ordinary knowledge. Several thinkers may be associated with this establishment, including Bacon, Galileo, Descartes and Newton. In this context, we shall focus briefly on Descartes (1596 – 1650) who wrote the *Discourse on Method* (Descartes, 1960 / 1637) which has been called "*one of the really important books in our intellectual history*"

(Butterfield, 1949). This small book offers four general rules for “*properly conducting one’s reason*” and has influenced thinkers and scientists since (ibid.). It is the second rule provided that is most central as it articulates a key characteristic of science and the scientific method, as it has been practiced since (Checkland, 1981: 46). This second principle for the conduct of good reasoning stipulates *to divide each of the difficulties that are examined into as many parts as might be possible and necessary in order to best solve it* (Descartes, 1960 / 1637). The assumption here is that when one is faced with some kind of complexity, i.e. most non-trivial everyday situations, one should attempt to decompose (analyze, take apart) it into as simple components as possible, so that these components may be understood; and then put that knowledge of the separated parts together thereby producing comprehensive knowledge of the whole situation initially faced – hence: first *analyze* the phenomenon and then *synthesize* available knowledge of the parts of that phenomenon. This approach of breaking down, or reducing, the phenomenon in question has dominated and continues to dominate most scientific thinking to this day (Franklin, 2009). We choose here to quote a contemporary analytical philosopher J.R. Searle (2007) who very clearly expresses this reductionist method of reasoning and understanding:
“*…in order to make any progress, we have to divide the huge problem /…/ into sets of smaller problems, and those into even smaller problems so that we can answer them in a piecemeal fashion. Our strategy is to divide and conquer: divide these questions into questions of a more manageable form, and then work on them one at a time. That at least is the method that I have followed all my life…*” (Searle, 2007, p.18)

He then continues with disclosing his underlying ontological assumption that motivates the reductionist method:
“*Just as human biology is an expression of the underlying physics and chemistry, so human culture, in all of its manifestations, is an expression of our underlying biological capacity for language, rationality, etc.*” (Searle, 2007. p.22)

Clearly, Searle articulates the underlying assumption that when faced with complexities (*here human culture*) that hinder straightforward understanding, one should break down the phenomenon into simpler components where some understanding is already available (*here language*). While this approach to reasoning and knowledge constitution is appealing and certainly may follow intuition, we shall soon see that it has at least one crucial shortcoming: it presupposes that comprehensive knowledge of a whole is equal to knowledge of each part as such, where the latter are understood to be isolated from the whole's context. Before detailing this shortcoming, however, we shall make a brief conception of the K-19 situation by employing the analytical approach to understanding.**[v]**

2.2 *K-19 conceived as an assembly*

When conceiving K-19 as an assembly or a set, we may understand it in terms of (a) its set of individual men serving onboard, conducting their pre-specified tasks, and (b) the submarine ship, made up of a number of mechanical and electric parts; all these components are put together into what was regarded as K-19. Conceiving K-19 as an aggregate (a collection, a set) informs us of the fact that K-19 includes two kinds of parts, human and non-human components, where each of these perform one or more specified functions. In this sense, the function of each crew member is to conduct well pre-defined activities that serve the ship in a purposeful manner. For example, a *Sonar Technician* operates sonar gear ('*sonar*' stands for 'sound navigation and ranging'). Thus the function of a Sonar Technician in the submarine is to operate sonar equipment in order to locate, identify and track submarines and surface ships – without this a submarine is blind. This specification of each component of the K-19 may go on until all components are understood. The analytical approach to reasoning and knowledge constitution assumes thus that once all components are understood, the knowledge of each component as such may be put together to make up knowledge of the whole: of K-19 as such.

2.3 *Assessment of analytical thinking*

It is now time to make a brief assessment of this analytical approach to comprehension and reasoning, as provided by modern science. The analytical approach regards any whole as an aggregate, that is to say as a set of parts that are put together to serve some end. Therefore, one of its key strengths is that it follows man's intuition: to isolate a whole from its context, decompose it into its parts until each part may be understood, put that knowledge of the separated parts together and thereby obtain knowledge of the whole. Secondly, this approach has clearly been successful in a number of situations. Since the time of the scientific revolution and Enlightenment, our societies have produced a never before experienced advancement in knowledge production and also the development of virtually every part of human life. To illustrate this, we can conceive of modern pharmaceuticals: scientists analyze a key recurring human illness, they identify its cause by means of isolation, experiments and observation, thereafter a solution is formulated in terms of a drug, and that drug is tested for its effects; if it fails a redesign of that drug is conducted and tested again. As a result, the pharmaceutical revolution has saved millions of lives.

As mentioned earlier, a limitation of the analytical approach is its key underlying onto-epistemological assumptions. It regards all wholes as mere aggregates, and therefore also assumes that knowledge of each part of a whole, obtained in isolation from its whole, is good enough for us to understand the whole after it has been synthesized with the knowledge of other parts of the given whole. The shortcoming comes from the common observation that a whole manifests characteristics that cannot be identified in any of its parts alone. This is so as these whole-properties emerge from a certain kind of interactions with the whole's parts and also the whole's environment (e.g. Checkland 1981, Klir, 1991). To continue with the pharmaceutical example, the pharma research industry has learned that it is not enough to test a new drug in isolation only. It is now a common practice that more and more drugs are tested for their potential interactions with other medications, with life styles, with food and other factors. This is so as a certain drug may manifest a certain kind of properties on its own, and rather different properties when it operates, intentionally or unintentionally, in interaction with other drugs or conditions (for example, both aspirin and blood-thinners like warfarin Coumadin – used to prevent heart attacks – help to prevent blood clots from forming; using these medications together, however, may cause excessive bleeding). Returning to the K-19 case study, we can see that the submarine as a whole manifests various characteristics that cannot be derived from any of its parts on its own, such as sailing, submerging and surfacing, striking against other ships, conducting rescue operations not programmed in advance. Just as flight is a key emergent characteristic of an airplane – none of an airplane's parts, such as the wings or the engine, can fly on its own – the submarine has its emergent properties. Therefore, it does not matter how much analysis is conducted on the K-19, providing us with detailed knowledge of its various parts – e.g. torpedoes or navigation functions – this will not provide us with knowledge of how the sub can submerge or surface, as these functions are emergent characteristics of the sub's parts interacting with each other in a certain manner. Further, no analysis, however sophisticated, may inform us why

K-19 came into existence nor why it is equipped with a nuclear power-station or nuclear missiles, as the reasons for all these and other properties of K-19 are to be found outside it, within its environment. Clearly, when a phenomenon is decomposed into its parts, its emergent properties are dissolved and cannot be accounted for when any part on its own is investigated. This key limitation constitutes the key *raison d'être* for *systems thinking*, detailed below.

2.4 *Systems Thinking: the whole as a system*

This section comprises a description of *Systems thinking*, as a reaction to analytical thinking as discussed above; the following account includes an exposure of its key message, an illustration of its working with the K-19 case, and then a reflection upon some of its strengths and limitations.

Just after WWII, Warren Weaver (1948) published an important message that the conventional methods of science are not good enough for the comprehension of the complexity perceived in non-trivial everyday phenomena. Weaver introduced a three-level classification of phenomena – problems of *simplicity*, problems of *disorganized complexity* and then problems of *organized complexity*. In this, phenomena of *simplicity* are represented by the engine, telephone, and radio, automobile or hydroelectric plant, etc. Its scientific methods come from classical mechanics dealing with a handful of variables with some kind of one-way deterministic relation. This implies that these methods of few-variables cannot help us much with the comprehension of phenomena that are complex in terms of many variables that interact, for example comprehension of living processes, cultural and political structures and dynamics.

Toward the end of the 18th Century, new methods were established for dealing with what Weaver calls disorganized complexity, where a very large amount of variables, say, one million, are addressed. Probability theory and statistical methods were developed to support our conception and reasoning with such phenomena as gases where a huge amount of molecules interact and whose behavior is averaged rather than exactly specified. More specifically, Weaver (ibid.) explains "It is a problem in which the number of variables is very large, and one in which each of the many variables has a behavior which is individually erratic, or perhaps totally unknown. However, in spite of this helter-skelter, or unknown, behavior of all individual variables, the system as a whole possesses certain orderly and analyzable average properties." (ibid. p.227), and "the motion of the atoms which form all matter. As well as the motions of the stars which form the universe, come under the range of these new techniques". (ibid. 228).

Weaver then continues with the question: "Why can one particular genetic strain of micro-organisms synthesize within its minute body certain organic compounds that another strain of the same organism cannot manufacture?" (ibid., p.230). "These problems – and a wide range of similar problems in the biological, medical, psychological and political sciences – are just too complicated to yield to the old nineteenth-century techniques which were so dramatically successful in two-, three- or four-variable problems of simplicity, these new problems, moreover, cannot be handled with the statistical techniques so effective in describing average behavior in problems of disorganized complexity." (ibid. p.230) These challenges represent situations where neither classical mechanics nor thermodynamics (i.e. statistical methods) can help us much, according to Weaver (ibid), as such problems are of organized complexity, that is: *"…problems which involve dealing simultaneously with a sizeable number of factors which are interrelated into an organic whole"* (ibid. p.231). Therefore, Weaver calls for a new advancement of scientific methods, to develop approaches that can support our conception and reasoning with organized complexity. Furthermore he suggests that there are early signs that such methods are being advanced, which includes sophisticated computation methods and mixed-team operations analysis practices. In this, he referred to the development of that which became known as cybernetics and control theory, information and communication theories, a heterogeneous body of thinking known as systems science, and also chaos theories, and complexity theories. While all these bodies, and other not mentioned here, have their own peculiarities, they all seemed to have at least one common denominator: they regard any whole as a system (Checkland, 1981, Ch:2).

Ludwig von Bertalanffy (1968), a thinker contemporary with Weaver and sometimes called the father of Systems Sciences (Hammond, 2003), offers us some further motives for the emergence of systems thinking, that is for our conception of something as a system rather than as mere aggregate or set. Hence: "One formulation of /…/ cosmic order was the Aristotelian world view with its holistic and teleological notions. Aristotle's statement, "*The whole is more than the sum of its parts*" is a definition of the basic system problem which is still valid". (von Bertalanffy, 1972, p. 407 – italics original). He continues with: "We must strongly emphasize that order or organization of a whole or system, transcending its parts when these are considered in isolation, is nothing metaphysical, not an anthropomorphic superstition or a philosophical speculation; it is a fact of observation encountered." (LvB: 408). He then concludes with: "The properties and modes of action of higher levels are *not* explicable by the summation of the properties and modes of action of their components taken in isolation. If, however, we know the ensemble of the components and the relations existing between them, then the higher levels are derivable from the components." (ibid. p.411)

J. Klir (1991: Ch.1), following R. Rosen (1986), suggests that any system manifests two fundamental yet very different kind of properties. *Thing-hoods* are properties belonging to the individual parts of a system, whether they are regarded being part of the whole or isolated. On the other hand, *Systems-hoods* are properties manifested by the whole only, and not manifested by any of the parts as such. For example, the ability to fly may be manifested by an airplane as a whole. Its engine or wings cannot fly on their own. Systems-hoods are in a sense independent of any particular part, in the sense that a system-hood may be produced by other different wholes, for example some birds can also fly.

P. Checkland states then that "The idea of emergent properties is the single most fundamental systems idea and to use this (and other) systems ideas in a conscious organized way is to do some 'systems thinking'." (Checkland, 1981: 667). He then continues with: "Throughout systems literature the core image upon which systems thinking is based is that of the *adaptive whole*. The concept of some whole entity (which may be seen as a whole because it has emergent properties) existing in an environment which may change and so deliver shocks to it. The adaptive whole may then survive in the changing environment if it can adapt to the changes." (Checkland, 1981: 668; our emphasis). Produced by his extensive review of systems literature, Checkland has identified four fundamental characteristics of an adaptive whole, as follows (bid: 678):

• *Emergence*: "… the whole will be seen as a system (rather than simply as an aggregate)
if the observer can identify some emergent properties of it as an entity"

• *Hierarchy*: "… the whole system may contain parts which are themselves smaller wholes (or 'sub-systems'). Thus, the human body can be regarded as a system but sub-systems such as the respiratory system or the blood-circulation system can also be identified within it. This means that systems thinking postulate a *layered or hierarchical* structure in which systems, part of wider systems, may themselves contain sub-systems, which may contain sub-sub-systems, and so on."

• *Communication & Control*: "… if a system is to survive in a changing environment it must have available to it processes of communication and processes of control. It must be able to sense the change in the environment and adopt a suitable response in the form of some so-called ‘control action’.”

Checkland continues therefore: “With the four concepts of emergent properties, a layered structure and processes of communication and control a very wide range of wholes may be described as systems capable (within limits) of surviving in a changing environment, systems thinking applies these ideas to a wide range of observed features of the world, the purpose being, in general, either to understand the world better or to intervene to improve some part of it.” (ibid. 678).

In parallel with, yet independently of, Checkland’s work, J.L. Le Moigne (1990) formulated similar terms in Francophone literature. In his conception, any system is regarded as a set of components that give rise to functionality and transform, all within an environment and in relation to some intentions (Le Moigne 1990: Chap. 3). Furthermore, an adaptive whole is understood as a hierarchy of three key sub-systems: operations, information and communication, and decision-making; all aimed at a successful survival (Le Moigne 1990: Chap. 4).

To be clear here, while von Bertalanffy’s (1968, 1972) and his colleagues’ contributions focused on theories of systems, the interest of Checkland and some followers was to assume selected parts of theory of systems and to employ them as intellectual guidelines for conception and planning of changes in social affairs; the interest there is thus not ‘systems theory’ but ‘systems technology’, or more specifically, its subset: ‘systems methodology’ (Checkland 1981, Ch: 2).

Before moving our attention to how systems thinking can help us conceive the situation of K-19, we wish to articulate a central implication of systems thinking regarding the constitution of knowledge of some selected phenomenon. This is that no amount of *analysis* of any phenomenon can provide us with comprehensive understanding of it. This is because when a phenomenon is taken apart, systems-hoods (i.e. emergent properties) disappear and thus cannot be perceived and understood e.g. when a child takes a radio apart to find the voice the radio emits. As a consequence, a key methodological implication is that *synthesis* should (also) be utilized when conceiving a non-trivial phenomenon. This implies that a phenomenon under consideration needs to be regarded as a whole, and within its context, so that its role and functionality may be comprehended.**[vi]**

2.5 *K-19 conceived as a system*

It is now time to conceive the K-19 situation as a system. To start with, K-19 may be regarded as a system in itself, constituted by a set of sub-systems and at the same time being part of a larger system. Examples of sub-systems include its engine department, made up of the ship's engines, engine staff, working procedures, tools etc. There also is the missiles department with the missiles themselves, its crew and also standard operating procedures, and there are a number of other sub-systems such as navigation, food, health, and the command function that directs and controls the behavior of K-19 as a whole, as a response to the command signals received from the Navy headquarters. The above and other sub-systems of K-19 may in turn be further decomposed into sub-sub-systems, such a missile or an engine, with further de-composition being possible until it ceases to make sense; all this analysis is aimed at generating knowledge of the phenomenon at hand, here K-19. All these K-19 sub-systems and their various sub-systems, are organized in a particular hierarchy, to give rise to the emergent behavior of K-19, including its ability to sail from one place to another place, to submerge and surface, to conduct a torpedo strike against another ship, and to fire off a missile whether submerged or not. These behavioral patterns are a result of the interaction of the various sub-systems, hence the ship's engine cannot sail on its own, nor can any other part of the ship do so; a torpedo as such cannot fire off by itself, it requires the assistance of the other sub-systems, such as navigation and command. Further on, we understand that K-19 regarded as a system is part of a larger system, firstly the Soviet Navy's submarine division, which in turn is part of the Soviet military system, which in its turn is part of the Soviet country, which in turn is part of… From this kind of contextualization of K-19 we may understand why it was brought into existence, and also the role or function of its unique capability to sail submerged for very long period of time, due to its nuclear powered engines, namely, to present a threat to the NATO countries. Without such a synthesis we may never produce the answer to the question of why does K-19 exist and whether it was designed to manifest some of its emergent characteristics, or systems-hoods in system language. If we advance this investigation further, we may recall that on 4 June 1961, when K-19 was conducting exercises outside southern Greenland, a major leak developed in the ship's reactor coolant system, causing the temperature to rise uncontrollably, and putting the whole ship in a very dangerous situation. The ship's command sub-system was not allowed to communicate with the Navy's command system, because of the radio silence it had imposed; this made it impossible for the ship's captain to request permission to abandon ship and rescue its crew, nor could any assistance be requested. Therefore, Captain *Nikolai Vladimirovich Zateyev* decided that a team of eight crew members would implement a new cooling system, and thereby make an attempt to prevent a disaster. This means that articulated in systems terms, K-19's decision sub-system initiated control actions, that by means of internal transformations could bring the systems into stability and thus ensure its survival, even though some of its internal components (crew and mechanical devices) ended their functionality and indeed their existence – however K-19 regarded as a system survived the adaptation process, and could thus be perceived as a viable system.

2.6 *Assessment of Systems Thinking*

A central strength and at the same time shortcoming of systems thinking is its central assumption of *functional alignment.* More specifically, the assumption implies that a system, such as K-19, is composed of a set of parts that are organized hierarchically so as to give rise to the emergent functions of the whole. In this, a second underlying assumption is that the parts of a system have only one role, which is to function in the context of its single whole: its system. The reason for this is that the root metaphor of systems thinking comes from studies of biological organisms. In these cases, a system's parts typically have one pre-determined specific functional area within its whole and have no meaning or identity outside its whole. For example, the heart or lungs of the human body have their own specific functions, both are needed by the human body to produce its systems-hoods, yet these sub-systems, or organs, have no meaning or independent identity outside the whole, and cannot survive there (other than by artificial means imitating the original context). While this biotic conception of a system certainly makes sense for the conception of biological phenomena, it presents a key limitation for the conception of social phenomena. This is so as parts of a social system, such as a human-being or a group of people operate differently: they are not limited to being fully aligned with one social whole only. For example, a body's organ, such as the lungs, cannot say: '*I am tired of working today so I will rest*', or '*I wish to quit my job for the moment*'. These sub-systems do not manifest separate interests, multiple or conflicting interests or aims; however this is something that we do experience in the domain of social phenomena. Also, people tend to be part of a set of social wholes, sometimes under a limited period of time and they can switch their social contexts. Peoples' desire and capacity to participate within several social contexts may also generate conflicting interests between these contexts. Clearly, parts of social wholes are not fully aligned and limited to one function only.

In the case of K-19 we know that some of the crew members did not wish to board the ship prior its departure and that some of crew members did not want to participate in the special taskforce assigned to rescue the ship; this being so as they expected, or knew, that they would never rejoin their families. Here we can clearly perceive a conflict of loyalty: the loyalty to the mother country and particularly its navy versus loyalty to their families. The Soviet state, and its armed forces, assumed that it owned the lives of their soldiers and could sacrifice them for the sake of the security of the country while some of these soldiers were not convinced about that commitment as their loyalty to their families proved to be stronger.

Empirical experience shows that humans, whether individually or group-wise, have various aims simultaneously in social contexts and that these aims or interests may change over time. In that way, the basic model of *a system* is too limited as intellectual spectacles to guide our conceptions of social phenomena, as the system genotype reduces or disregards key empirical features inherent in social phenomena, and thus limits our understanding of these phenomena.**[vii]**,**[viii]** More specifically, systems thinking commits itself to a kind of macro-reductionism, where the behavior or function of a whole's parts is fully determined by and aligned with its whole. In a sense this is not so surprising, as this shortcoming represents an anti-pole to the limitation of analytical thinking's micro-reductionism, which caused a reaction and development of systems thinking.

3. *Towards Post Systems Thinking*

In the text above we have made an attempt to expose two key approaches to support our conception of and reasoning about complexities: analytical thinking with its taking-apart and system thinking with its holism. While each of the two approaches manifests various merits and limitations, we have exposed a key limitation in their conceptualization of a social phenomenon, respectively. A question that now emerges is: *Is there any alternative to the two*?

In the next section we shall expose two very different alternative approaches to comprehension, where each offers its own way to overcome the limitations of both analytical thinking and systems thinking. We start with the exposition of the *encaptic relations* and then follow this with an exposition of *assemblage relations.* We proceed by exposing each of these together with a brief illustration of the K-19 case, and will then conclude with a short assessment of the merits of the two approaches.

3.1 *Encaptic relations*

The late Dutch philosopher and professor of law, Herman Dooyeweerd (1894-1977), developed a highly original philosophical body sometimes called the *Philosophy of the Cosmonomic Idea*. This includes contributions regarding the nature of diversity and coherence of everyday experience (ontology), the transcendental conditions of theoretical thought (epistemology), and the relationship between philosophy and religion, among others – most comprehensively presented is his opus magnum: *A New Critique of Theoretical Thought* (Dooyeweerd, 1955).

In this context we have utilized Dooyewerd's (1997) proposal for the notion of encaptic relations and the associated notion of aspects or modalities of reality. Dooyeweerd observes that things can be combined into a whole in at least two ways. One is the biotic notion of the *whole-part*, as summarized in the Aristotelian expression 'the whole is more than the sum of its parts' and as articulated in systems thinking above. In this a whole's parts cannot exist or function, nor be understood comprehensively, apart from the whole of which it is part, such as an organ being part of an organism. The second combination of things is what may be termed here as a whole-whole relation, where one whole is encapsulated with another whole, as a *sub-whole*, can thus not be subsumed as a part. This kind of encaptic relation attempts to do justice to our empirical experiences when a particular whole is encapsulated within another whole as sub-whole, however, where that sub-whole can exist and function and also be comprehended apart from the other whole into which it is encapsulated. An example illustrates this as follows: a small rock in a bird's gizzard may assume a function in the bird's digestive process. The rock is not a part of the bird, rather it assumes a kind of passive function and the rock can exist without the bird yet it cannot perform the same digestive function without the bird. Dooyeweerd notes that in such whole-whole relation, one whole is governed or obeys one kind of norms or laws while the other whole is governed or obeys another kind of norms or laws; this means that there is a significant difference in the nature of the two entities and therefore these should be conceived in terms of encaptic relations. Dooyeweerd says: "… *an encaptic relation occurs between idionomies with an intrinsically different nature; these idionomies can never relate as part to a whole.*" (Dooyeweerd 1997: 66-67). In the example of the bird and its rock, the first mentioned is qualified biotically while the last mentioned is qualified physically. On the other hand, in a genuine whole-part relation both the whole and its part are governed by the same kind of norms or laws, such as is the case with human body and its heart or lungs that are all qualified biotically. We may thus define an encaptic, or whole-whole, relation as taking place when a sub-whole exists and acts within the internal organization of a ‘larger’ whole which has a different qualifying function from the sub-whole, while the qualifying function of the sub-whole is over-ridden by that of the larger whole. In all this, the notion of encaptic relations presupposes Dooyeweerd’s notion of human reality manifesting a number of distinct characteristics, also called modalities or aspects (ibid.). More specifically, Dooyeweerd maintained that human thought is based upon and bound to our experience and that experience exhibits a number of distinct modalities (or aspects, or dimensions, or spheres) of normativity and laws. Dooyeweerd proposed fifteen modalities, in the following order: arithmetic, spatial, kinematic, physical, biotic, sensitive or psychic, logical, historical, lingual, social, economic, aesthetic, juridical, ethical and pistic; however, Dooyeweerd’s intention was not to construct a final and exclusive map of human experiences, it is a proposition and he welcomed motivated suggestions for modifications.

The significance of this Dooyeweerian encapsis is central for our investigation here. This is so as this encapsis clarifies why the nature of a whole cannot be explained or predicted from the knowledge of sub-wholes that are bound to it, namely sub-wholes are governed by other norms or laws than the larger whole, and therefore cannot be considered as causes of the larger whole in which they happen to be bound, at the moment. Indeed, these sub-wholes may be regarded as necessary for some specific functioning yet not as sufficient.**[ix]**

### 3.2 *K-19 as Encaptic relations*

We will now turn our attention again to the case of K-19 where we can regard an individual in her social roles of a crew member and of a family member. As crew member, a soldier on a submarine was part of the navy and the military defense establishment, and ultimately part of the Soviet country, where the latter is founded historically and qualified juridically. The individual versus the country manifest an encaptic relation, as she is transcendent to legal norms (ref), yet may submit herself to these. On the other hand, in the context of a family the same individual simultaneously assumes an encaptic relation to that other social whole: the family. In the context of the latter she is qualified ethically, with the kernel, or motivation, of love (the family maybe *founded* biotically, in the parent-child or sibling relations, yet is *qualified* ethically). We can now identify a conflict zone: a family may span across one or more countries – disregarding geographical and legal boundaries and their diversities. It is thus possible that two individuals who belong to the same family may be subordinated to two different countries, with two very different juridical standards that may or may not be in conflict with each other. Further on, Dooyeweerd postulates clearly that ethical norms surpass legal norms – the latter results from a social contract and seeks justice while the former from an individual's values and conviction, ultimately her love. This distinction can be illustrated by the following brief example: imagine a couple about to be married in Church. Legal standards may establish certain conditions of the two newlyweds, such as their belongings being shared equally. However, it would be nonsense to stipulate legally that the two ought to love each other, as that is a moral condition which cannot be enforced legally.

3.2.1 *Assessment of Encaptic relations*

The conception of the K-19 situation and its crew members described above articulates some hidden circumstances which cannot be accounted for by either analytical thinking or system thinking. One is that individuals should not be regarded as independent parts of the Soviet country (as the analytical approach implies) or as fully dependent parts of that country (as the system approach implies). An individual may assume a whole-whole relation with different social entities and thus submit herself to different normative standards at the same time, sometimes conflicting.

However, this gives rise to a key question: how can we understand a conflict between two social entities where each is qualified, by or operates upon, two different normative standards, such as in the case K-19 case? While Dooyeweerd (1997) does not provide a final solution to this kind of normative challenge (as we understand it) he does offer conceptual guidance for how to think about such situations. This includes an entity's sphere of sovereignty, the aspects of reality with its norms or laws guided by their respective kernels: all these modalities characterize entities. Our interpretation is here thus that the family as an entity is qualified by ethical norms which surpass a state's juridical normativity, and thus that the individual should be given the ability to make her own choice whether to join the military service or not. This suggests that is more appropriate that a crew member is loyal to, and prioritizes, her family rather than the state.

3.2.2 *Assemblage relations*

In this section we shall expose yet another approach to the conception of social relations: the *assemblage approach*. Similarly to the encaptic approach detailed above, the assemblage approach offers an alternative to both the analytical and the systems approaches, and potentially offers conceptual support that deals with some of the limitations of the two mentioned approaches. We will start this exposition with a brief summary of the assemblage approach and then illustrate its working on the K-19 case; its assessment will follow.

Assemblage theory is a kind of social ontology that has been formulated by the contemporary philosopher Manuel DeLanda (2006). However, his effort is based on the novel work of two renowned French philosophers Gilles Deleuse (1925-1995) and Pierre-Félix Guattari (1930 – 1992). DeLandas contribution is to bring their work together into one coherent theoretical body and to expose it systematically, including clarifications and some additions. In this sense, DeLanda calls his work the '*neo theory of assemblage*', or 'assemblage theory 2.0' (ibid.) – we will assume that version of the assemblage conception here.

Assemblage theory proposes that there are two kinds of relations in social phenomena; these are called *totalities* and *assemblages*. Totalities refer to a situation where relations between components of such a phenomenon are set in such a way that they have no independent identify, meaning independent existence from the phenomenon that they are a part of, from the relation in which they exist; this is also known as the relation of *interiority.* In such cases, parts are fused into a whole, as is the case of organs within the human body: the brain or kidneys have no meaning and function without the whole, the body (not to be confused with the situation when an organ is taken out of a body for transplantation and for a moment functions within an artificial context that imitates the original environment).

Assemblage relations, on the other hand, are said to be characterized by their relations of *exteriority*, meaning relations where components within a phenomenon may be detached from it and enter a relation within another phenomenon: changing its participation from one assemblage to another assemblage.

Totalities generate emergent properties from the interaction of their parts, and the relations between the parts are conceived in a similar fashion as within systems thinking. In contrast, assemblage is understood as another kind of a whole that also generates properties of its own, not reducible to its parts. However, parts within an assemblage are not assumed to be fused into its whole and fully aligned, integrated with, or absorbed by, it. Parts of an assemblage may exercise some capabilities or functions that are unique to its being part of a particular assemblage, however, its parts can be detached from that assemblage, followed by independent function and/or entering into a relation with another kind of assemblage, where such a part may assume some new functioning specific for that context. To provide a brief illustration of this, we can refer to our own way of functioning. When a part of our employer (assemblage), e.g. as an airline pilot, we can function in a certain manner, however when being part of another assemblage, e.g. a family, we function in very different way. Next, Assemblage Theory postulates that any assemblage operates with two kind of functional modes.

The first mode of functioning refers to the situation when a part of an assemblage functions *materially, expressively,* or both. Material-functioning refers to a part's materiality such as its physical location, structure, shape, or movements, for example a building, a machine and individuals and groups of people. Expressive-functioning refers to a part's expressiveness that gives rise to information that is communicated, in some manner. This includes both linguistic and non-linguistic expression; the latter may be signals sent by a building's shape or a human posture. For example, the headquarter building of the US Military is constructed in the form of a pentagon, and is officially known as the Pentagon; in this instance the building operates both materially and expressively.

The second mode of functioning refers to the situations when parts of an assemblage This first describes a situation where the components of an assemblage contribute to a stabilization of the whole assemblage. The second instance accounts for a situation when the components contribute to a destabilization or a change of the assemblage. For example: a building, such as the Pentagon, is built in such a manner that its components keep it fixed, both materially and expressively. Archeologists, on the other hand, have found certain cave paintings, which are exceptionally well-preserved after several thousand years, yet their intended expressivity has vanished, we can only guess what their message was. Likewise, a social organization such as the Roman-Catholic Church has been preserved, both materially and expressively, for two thousand years, while other organizations may emerge rapidly and then vanish. As an example of this, the company *Instagram* which provided functionality for sharing pictures via Internet was less than a year old when it was acquired by another company (Facebook) followed by a process where the first-mentioned organization was fused into the second, and thus ceased to exist as an independent entity.

The development of Assemblage Theory was initiated by a reaction to two kinds of reductionism (DeLanda, 2006). The first is what he calls *micro-reductionism;* it assumes that all phenomena may be decomposed into their very basic parts and thereby understood; this implies that individuals determine completely the behavior of its whole, and assume a similar position to that of analytical thinking as discussed above. The second kind of reductionism is labeled *macro-reductionism* by DeLanda. This assumes that only the function of a whole is of interest, as its parts are only there to serve it so that the interests of the whole are fulfilled; this implies that the whole determines the behavior of any individual that participates in the whole. This macro-reductionism assumes a position similar to systems thinking as discussed above. By offering a distinction between two kinds of wholes – *totalities* and *assemblages* – Assemblage Theory attempts to do more justice to empirical experiences, by accounting for two kinds of wholes, one where parts are fully absorbed and can only function and be meaningful within its whole and one where a part can be detached from its current whole and engage within another one.

### 3.2.3 *K-19 as an assemblage*

From the exercise conducted above, we may clearly conclude that K-19's actual behavior more meets the conditions of an assemblage than of a totality (i.e. a system). This is so as various parts of K-19 may be detached from it and can assume a function in the contexts of other assemblages; such was the case with the crew members who were part of their families, and at the same time part of K-19. Other parts, such as the ship's unique nuclear power station or its torpedoes, its navigation units and its food-providing arrangements, could all be detached and installed with some other context, such as a on a surface-ship or on land. This shows that conceiving K-19 as a totality eliminates the understanding of its parts' ability to change its contexts, thereby potential loyalty conflicts.

Next, the K-19, the ship as such, manifests a clearly material functionality, as do its various parts – torpedoes, nuclear power station, ballistic missiles, and various departments within the ship – and its context – such as the sea it navigates in and the other ships it relates to. K-19 also manifests expressivity in various manners; its physical shape signals that it is an entity for war, likewise the soldiers are organized into a strict hierarchical system that is communicated with various symbols, such as names for grades and symbols on the uniforms, the soldiers also assume various rituals, such as songs, sayings and stories, that function as community bonding and identity establishing. Furthermore, materially manifested acts, such as punishment of a soldier who performed unwanted behavior, signal to other crew members what is expected of them.

Finally, moving on to the material aspect of the (de)territorialization functionalities, the whole ship was built to withstand material challenges such as weather, pressure of deep water and weapon strikes. Here, K-19's accident was the result of a faulty nuclear power station, when the cooling systems broke down. This put the whole ship into serious danger whereby the process of its de-territorialization was initiated. On the other hand, the crew's hierarchical organization and informal loyalty saved it from another kind of de-territorialization that was initiated yet held back, when some crew members' loyalty for their families made them refuse initial orders to repair the cooling systems and thus expose themselves to deadly radiation. This initiated de-territorialization was stopped by the soldiers' expression of belonging to a community and by the formal hierarchy.

In this case, we may conclude that K-19 as an assemblage was exposed to two kinds of *de-territorialization*: first a process of *de-territorialization* (i.e. cooling system) and secondly the crew members' simultaneous belonging to another assemblage (i.e. family) initiated the other process of de-territorialization, through an attempt at mutiny; in the second instance however, the specific formal hierarchy and its culture (with its code of conduct, songs, rituals, histories) contributed to maintaining organizational stability, or territorialization, where it also produced a recovery of the assemblage's cooling system, hence *de-territorialization* of its ship – this is shows the interplay between two kinds of *de-territorializations*: material and expressive.**[x]**

3.3. *Assessment of Encaptic and Assemblage relations*

It is now time to make an evaluation of the encaptic approach and the assemblage approach to the conception of a phenomenon, in relation to the limitations presented by the analytical and the systems approaches.

To start with, we can conclude that both encapsis and assemblage, as intellectual conceptions, offer us the ability to account for the empirical experience that a phenomenon may be conceived as a whole, with its emergent properties, and with parts of the whole that are either fused into that whole and lack their own identity, or that can maintain a certain level of autonomy, and therefore function within various wholes. This is something that neither analytical thinking nor systems thinking can offer us.

This means that both the encaptic conception and the assemblage conception are able to recognize that we experience two kinds of wholes. On the other hand, while encaptic conceptions rely on the notion of norms and laws as well as founding and qualifying modalities, assemblage conceptions utilize conceptions of materiality and expressivity as well as of territorialization and de-territorialization. The two approaches can thus be perceived as rather different from each other, yet can both be used to offer a plausible conception of complex phenomena's functioning.

To be sure, neither of these two approaches was intended as operational theory or methodology; they are rather philosophical bodies (social ontologies) aimed to guide a conception of our experience and thus potentially inform development of empirical theories of our experiences.

4. *Discussion and Conclusions*

Modern systems thinking with its holistic message has emerged as a reaction to analytical thinking's atomism. In this essay, we have attempted to advance the argument that systems thinking, as an intellectual position while offering us some important conceptual features – the explicit recognition and accounting for emergent properties manifested by a phenomenon at hand – also imposes on us the macro-reductionism; this conceives parts of a whole fully aligned with its whole's aim and being devoted to it only, without the possibility of being part of another whole, whether simultaneously or at another point of time. This is unfortunate as such conception does not do justice to our empirical experiences, as we have shown with the case of the Soviet submarine K-19. We have recalled that others have pursued a similar argument, in one way or another, however, we have not only provided a critique of systems thinking and related it to analytical thinking; we have also presented two different theoretical bodies that may surpass both the macro-reductionism of systems thinking and the micro-reductionism of analytical thinking; these are the notions encaptic relations and assemblage relations.

At the moment, holistic or systems thinking often presents itself as a solution to the limitations of analytical thinking, their micro-reductionism (e.g. von Bertalanffy, 1968, 1972; Checkland 1981, Klir, 1991, Le Moigne, 1990; Flood & Jackson, 1991). While systems thinking may remedy the limitation of analytical thinking we should not become blind and assume that it does not impose on us its own shortcomings. From our elaboration of the situation of the submarine K-19, we can clearly see that *each* of the four intellectual devices reviewed here – *analytical, systemic, encaptic,* and *assemblage* – can offer us something in their function of intellectual guide for the conception and comprehension of a complex phenomenon at hand. As a consequence, we suggest that there is a need to further advance our conceptual apparatus, so that it can account for all identified features of a phenomenon rather than account for only some of them, as is the current tendency.

It was not the purpose of this elaboration to list all existing post-systems approaches; we have presented only two rather different approaches to support our conclusion here for a *complementary approach*, rather than the current more imperialistic where one approach surpasses another. After an identification of potential candidate approaches, there is a need for theoretical elaboration and practical tests with regard how to synchronize or even integrate the various approaches – with the clear aim of offering us an intellectual device that can guide a more comprehensive conception than otherwise.

Such advancement must not however be limited to theoretical bodies, as reviewed here. The various operationalizations of these theoretical bodies, often in the form of methods and methodologies, should also be addressed as these are utilized as intellectual tools for actual intervention in social affairs. To illustrate this point, we may consider one of the most sophisticated systems tools: Peter Checkland's *Soft System Methodology* (SSM), (Checkland, 1981; Checkland & Scholes, 1990). Among its various features, SSM mandates the utilization of the so-called conceptual modeling that is about the conception of a subsequent series of activities to be conducted by the phenomenon conceived. For example, painting a fence may require such activities as assessment of the current state of the fence, decision of desired color, acquisition of paint and brush, etc. SSM links these activities to key features of the phenomenon at hand: customer, actors, transformation, world view and environment (e.g. Checkland & Scholes, 1990). While such an exercise is certainly suitable for understanding key features of the phenomenon at hand, it manifests the above-mentioned macro-reductionism as it disregards the involved actors' multi-functionality, that is their synchronic or a-synchronic participation in other contexts and thus the potential emergence of conflicts of interest; an example of such a conflict of interest could be the workman painting the fence in our illustration, who also owns a company that sells paint and brushes; this would motivate him to choose his company as the supplier for the paint and brushes whether these are the most appropriate or not; due to its systemic roots, SSM cannot recognize such an everyday tension of interests; to be sure Checkland (e.g. Checkland & Scholes, 1990) proposes later in the development of SSM the so-called 'Political Analysis', yet this is in practice

limited only to the question: 'are there any power-tensions involved here?', without offering any direct linkage to the SSM's modeling tools, making it impossible to detect such conflicts of interest). Similar critique may be delivered to other operationalizations of both analytical and systems thinking, including R.L. Ackoff's sophisticated 'Interactive Management' approach (e.g. Ackoff et al 2006), S. Beer's 'Viable System Model' (e.g. Beer, 1985), or the 'System Dynamics' approach (e.g. Sterman, 2000).
Given the argument developed here, we would like to invite the reader to pursue a most necessary development of theoretical bodies and their operationalization, so as to do justice to our experiences, offering increased understanding and thus more informed decision-making about various interventions in human and social affairs.

**NOTES**

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**iii.** To be sure, systems thinking can be charged with several other kinds of reductionism not addressed here. One is manifested by the famous debate between J. Habermas and N. Luhmann during the 1970's (e.g. Habermas & Luhmann, 1971). In this, Habermas charged Luhmann, among others, with the inability of systems theory to properly account for central social characteristics: the life world (Lebenswelt), understanding (Verstehen) and trust (Vertrauen), thereby reducing the social to the biological. Another critique is delivered by Strijbos (1995, 2010) who observed that system thinking is unable to address human and social normativity, rather it continues with a technical worldview. In his ground-breaking attempt to deal with questions of systems normativity, W. Ulrich uncovered another kind of reductionism, the so-called open system fallacy, for example systems thinking may ignore a system's victims, or those affected by it yet not affecting it, or as he puts it: "'open,' in contrast to 'closed' systems models consider the social environment of the system; but as long as the system's effectiveness remains the only point of reference, the consideration of environmental factors does nothing to increase the social rationality of a systems design. In fact, if the normative orientation of the system in question is socially irrational, open systems planning will merely add to the socially irrational effects of closed systems planning. For instance, when applied to the planning of private enterprise, the open systems perspective only increases the private (capitaloriented) rationality of the enterprise by expanding its control over the environmental, societal determinants of its economic success, without regard for the social costs that such control may impose upon third parties." (Ulrich, 1988, p. 156, orig. italics; with reference to Ulrich, 1983, p. 299).

**iv.** Methodological note: the case study of K-19 presented here is used throughout this essay in a rudimentary manner, more sophisticated elaborations would require more space; the presented illustrations fulfill their function as an illustration of the pursued argument.

**v.** Analytical thinking has attracted a significant amount of criticism, not least from systems thinking, for some central criticism see Checkland (1981), Klir (1991), Flood and Jackson (1991), Le Moigne (1990). However a review of that critique is outside the scope of the argument advanced here.

**vi.** Systems thinking has attracted some criticism, (e.g. Klir 1991), however review of that critique lies outside the scope of the argument pursued here.

**vii.** We wish to make a brief mention of the fact that somewhat similar critical remarks have been delivered by some key systems thinkers, unfortunately without much recognition. For example Ackoff and Gharajedaghi (1996) proposed an ontology of systems that differentiates between mechanical systems, biological systems and social systems, in terms of their teleology. W. Ulrich (1983) makes us aware of the open system fallacy, which implies that the biological root of systems thinking makes us disregard the actors that are affected yet cannot affect the system, which he calls the victims. Also, E. Moring (1977) presented critical remarks against holistic thinking.

**viii.** We also wish to highlight the fact that the systems thinking approach, or its holistic conception, is not limited to the domain of systems science or systems thinking. More implicitly, the idea of a whole, where its parts are infused and thus lack their own independent identity or multiple roles, is also inherent in central theoretical bodies of social thinking; one such notable idea is the structuration theory as put forward by A. Giddens (1984). However, investigation of these theoretical bodies lies outside the scope of this elaboration, and our intention is only to highlight that the message advanced here has a wider relevance.

**ix.** Dooyeweerd's philosophical work has attracted some criticism (e.g. Wolterstorff, 1983; Friessen, 2009; Strauss, 2009; Chaplin, 2014), but a review of that critique lies outside the scope of the argument pursued here.

**x.** Assemblage Theory has also attracted some critical remarks (Brown, 2010), however a review of that critique lies outside the scope of the argument pursued here.

References

Ackoff R. L., Gharajedaghi, J. (1996). Reflections on systems and their models. *Syst. Res.* 13(1), 13–23.

Ackoff, R. L., Magidson J., Addison H. J. (2006). *Idealized Design: How to Dissolve Tomorrow's Crisis… Today*. Upper Saddle River: Pearson Prentice Hall.

Beer, S. (1985) *Diagnosing the System for Organizations;* John Wiley, London and New York.

Bertalanffy, Ludwig von (1968). *General system theory: foundations, development, applications.* New York: Braziller.

Bertalanffy, Ludwig von (1972). The History and Status of General Systems Theory. *The Academy of Management Journal*, Vol. 15, No. 4, 407-426.

Brown, S.D, (2010). Between the planes: Deleuze and social science. In: *Deleuzian Intersections: Science, Technology, Anthropology*, eds: Jensen, C.B., Rödje, K., Berghahn books, London, pp. 101-121.

Butterfield, H. (1949). *The Origins of Modern Science* 1300-1800. London: Bell.

Chaplin, J. (2014). *Herman Dooyeweerd: Christian Philosopher of State and Civil Society*. Notre Dame: University of Notre Dame Press, 2011.

Checkland, P. B. (1981). *Systems Thinking, Systems Practice*, John Wiley & Sons Ltd.

Checkland, P. B., Scholes, J. (1990). *Soft Systems Methodology in Action*, John Wiley & Sons Ltd.

DeLanda, M. (2006). *A New Philosophy of Society: Assemblage Theory and Social Complexity* London & New York: Continuum.

Descartes, R. (1960 / 1637). *Discourse on Method and Meditations.* New York: The Liberal Arts Press (trans. : L. J. Lafleur).

Dooyeweerd, H. (1986). A Christian Theory of Social Institutions. The Herman Dooyeweerd Foundation, *La Jolla, California*; pp. 64-78.

Dooyeweerd, H. (1997) [1955]. *A New Critique of Theoretical Thought, Edwin Mellen*. Volume III: The Structure of Individuality of Temporal Reality.

Flood, R.L., Jacksson, M.C. (1991). *Critical Systems Thinking: Directed Readings*. Wiley, London.

Franklin, J. (2009). *What Science Knows: And How It Knows It,* New York: Encounter Books.

Friessen, G. (2009). 95 Theses on Herman Dooyeweerd. *Philosophia Reformata* 74: 78-104.

Giddens, A. (1984). *The Constitution of Society. Outline of the Theory of Structuration.* Cambridge: Polity Press.

Habermas, J., Luhmann, N. (1971). *Theorie der Gesellschaft oder Sozialtechnologie – was leistet die Systemforschung?*(TSG), Frankfurth a.M., Suhrkamp.
Hammond, D. (2003). *The science of synthesis. Exploring the social implications of general systems theory.* University Press of Colorado, Colorado.
Huchthausen, P., (2002). K-19: The Widowmaker, *National Geographic* (Washington, DC).
Jeans, J. (1947). *The growth of physical science*. Cambridge: University Press.
Klir, J. (1991). *Facets of Systems Science*. Plenum, New York.
Le Moigne, J.L. (1990). *La modélisation des systèmes complexes,* Éd. Dunod, Paris.
Morin, E. (1977). *La Methode. 1. La Nature de la nature.* Paris: Seuil.
Rosen, R. (1986). Some comments on systems and system theory. *Int. J. Gen.* Syst. 13, 1.
Searle, J.R. (2007). *Freedom & Neurology. Reflection on Free Will, Language and Political Power.* Colombia University Press.
Singer, C. (1941). *A short history of science to the nineteenth century.* Oxford: University Press.
Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. New York: McGraw.
Strauss, D.F.M. (2009). *Philosophy: Discipline of the Disciplines.* Paideia Press, Grand Rapids, MI, USA.
Strijbos, S. (1995). How can systems thinking help us in bridging the gap between science and wisdom? *Systems Practice* 8.4 (1995): 361-376.
Strijbos S. (2010). Systems thinking In: *The Oxford Handbook of Interdisciplinarity,* Frodeman R, Thompson KJ, Mitcham C. (eds.). Oxford University: Oxford; p. 453–470.
Ulrich, W. (1983). *Critical Heuristics of Social Planning: A New Approach to Practical Philosophy.* Bern, Switzerland: Haupt. Pb. reprint ed. New York: Wiley, 1994.
Ulrich, W. (1988). Systems thinking, systems practice, and practical philosophy: a program of research. *Systems Practice* 1, No. 2, pp. 137-163.
Weaver, W. (1948). Science and Complexity. *American Scientists* 36, 536.
Whitehead, A.N. (1925). *Science and the Modern World.* New York: Macmillan Company, Vol. 55 of the Great Books of the Western World series.
Wolterstorff, N. (1983). *Until Justice and Peace Embrace.* Grand Rapids: Eerdmans.