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rearranging structural couplings and the paradox of moral-based sustainability-enhancing feedback

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The circular economy

Rearranging structural couplings and the paradox of moral based sustainability-enhancing feedback

1. Introduction

Geissdoerfer et al. (2017), among others, has suggested that the circular economy (CE) could become a new paradigm of sustainable development in general. In contrast, Korhonen et al (2018b) argue that much more work needs to be done before CE can become a new paradigm in the sustainable development of the global society. They find that the engineering and natural science-oriented studies constitute the biggest body of knowledge behind CE and have been developed in isolation from strategic, management and organizational studies or studies typical for social sciences. They therefore adopt a critical approach to the policy and practice orientated concept of CE, and ague that it is not a theory but an emerging and powerful approach to industrial production and consumption. Also, they underline, that social science theoretical research is very important for securing the actual impacts of CE work toward a more sustainable global society in the short and in the long term.

In this paper, we have chosen to take up the challenge posed by Korhonen et al (2018b) from a Luhmannian social systems theoretical point of departure (Luhmann 1980, 1981, 1987, 1989, 1998, 2002, 2004, 2012[1997], 2018[2000], Luhmann et al 2013). As a profound social theory, it can contribute by bringing a thorough theoretical understanding of how the concept of the CE relates to semantics, structure, and the evolution of structural couplings as core concepts.

As a moral communication, the CE semantics rings the alarm bell related to the linear "take, make, dispose" model of production (Ellen MacArthur Foundation, 2015). Moral communication does not constitute a function system (Roth et al, 2015), and does in that sense not play a role as integrating society, but Luhmann attaches it a kind of alarm function in the modern society, if difficulties cannot be solved by symbolically generalized media or by the function systems (Luhmann 1997/2012, p. 244). Inspired by Churchman's work (Churchman, 1968, 1979, 1982; Ulrich, 1988), Valentinov (2017b) suggests, that moral communication can be feedback-centered, and he points to the complexity-sustainability tradeoff (Valentinov, 2013, 2014). In line with Luhmann, he argues, that moral communication may laying bare the tendency of the systemic feedbacks, that are rather complexity-maintaining instead of sustainability-enhancing (Valentinov, 2017b).

The paper analyzes how the moral based semantics of CE may become a sustainability-enhancing feedback mechanism changing the structure through potentializing an evolutionary rearrangement of structural couplings. Also, social systems theory can contribute to critically scrutinizing for the limitations if CE should be understood as an approach for sustainable development in general.

While illustrative cases of CE business practices exist, the conceptual approach in this paper contributes to answer the call by Korhonen, by conceptually laying bare "why the CE transformation is not easy" and therefore still far from becoming a systemic change – as well as the semantics limitations as a general sustainability approach in front of the multicontextuality. The research question is: does CE have the prospect to become a sustainability-enhancing feedback mechanism potentializing an evolutionary systemic rearrangement of structural couplings, and may it encounter limitations as a general approach for a sustainable development?

After now having situated the research question, the section 2 outlines this paper's relation to the body of CE literature, the analytical strategy as well as the core concepts of social systems theory related to the CE – in particular the complicated co-evolution of semantics and structure, as well as systemic transition and rearrangement of structural couplings.

In section 3, it is elaborated how matter and materiality is perceived by social systems theory (Overwijk 2019, Valentinov 2013, Luhmann 1982, Luhmann 2012) and how social systems through a four-stage structural coupling enact a metabolism with nature (elaborated based on Lippuner, 2011; Haberl et al, 2016; Marx, 1976), measurable by the scientific system. Used as feedback mechanism (as well as measurement of the circularity of this metabolism) (Haberl et al, 2019, Haas et al 2020) it may "irritate" social systems and generate reflexion and sensibility towards the outer environment. It is argued that such a feedback may potentially become a sustainability enhancing feedback mechanism if structurally coupled to relevant social systems. However, as social systems consist of communication and only communication communicates, matter and materiality as well as psychic systems and the human bodies are not part of social system, but environments to social systems.

In section 4, it is re-acknowledged, that for CE to coevolve with structure, strategic decision-making is required in organizations, as well as reprogramming of the organizations (Roth, 2014). Strategic decision-making, however, is a paradoxical and evolutionary process (Foerster 1992, Luhmann 2018 [2000], Nassehi 2005, Roth 2014, Seidl and Mormann 2015, Rasche and Seidl 2017), which is best conceptualized as metacommunication. Further, the structural coupling of organizations into organizational polycentric networks (Teubner 1993,2011, Neumann 2011, 2012, Neisig 2020) potentially closing the loop based on CE-semantics (eventually stabilized and enhanced by a modern digitalization) is not an easy process due to organizations being operational closures and self-referential decision-making machines. Moreover, such structural couplings may generate a new complexity. In section 5, it is argued, that a moral sustainability-enhancing systemic feedback, such as CE, is not enhancing the sensitivity of the broad multicontextuality (Roth et al, 2015, Roth 2019, Roth et al 2020), and is therefore not capable of enhancing sustainability in a general sense. On top of that, it is argued, that sustainability-enhancing feedback, instantly also creates a new complexity-maintaining feedback – as these two types of feedback seem to be the unity of two sides in a distinction. Thus, sustainability is not a stable situation but an always ongoing wrestling of different sensitivities and different observation perspectives. Thus, the CE may enhance certain aspects of sustainability, but does not seem to enhance a general paradigmatic shift towards global sustainability. The argument is concluded in section 6, and recommendations for practice as well as future research stated.

2. The CE and the key concepts of social systems theory: semantics, structure, and evolution of structural couplings – the analytical strategy

Defining the CE as concept

CE has become a concept attracting both political and business interest around the world (Korhonen et al, 2018a), and is seen as an approach to economic growth in line with both sustainable environmental and economic development (EMAF et al., 2015; EMAF, 2013; EMAF, 2012; CIRAIG, 2015; COM, 2015; COM, 2014). Also an increasing scholarly interest is documented by Alhawari et al (2021), who has conducted a search in the Scopus database from year 2004 up to 29 November 2020 finding a total number of 1408 articles, showing an exponential growth, with 1277 articles published since 2017.

Several reviews (e.g. Kirchherr et al, 2017; Korhonen et al, 2018a, b; Alhawari et al, 2021) show, however, that the definition, scope of the concept as well as the unit of analysis are diverging. Kirchherr et al (2017) gathered 114 definitions which were coded on 17 dimensions. Kirshherr et al (2017) agree with Geissdoerfer et al. (2017, p.759) that the most prominent CE definition has been provided by Ellen MacArthur Foundation (2012, p.7) which reads:

> "[CE] an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."

This regenerative approach contrasts with the traditional linear economy (as counter-concept), which has a "take, make, dispose" model of production (Ellen MacArthur Foundation*,* 2015).

The findings in Kirchherr et al (2017) indicate that the CE is most frequently depicted as a combination of reduce, reuse and recycle activities, whereas the literature often times do not highlight that CE necessitates a systemic shift. Korhonen et al (2018b) depicts CE as an essentially contested concept as defined by Gallie (1956). According to Gallie a concept becomes essentially contested if there is agreement on the means and goals of a concept but disagreements on how to define it, which units of analyses to use to capture the dynamism, what the conceptual cornerstones are and what methodology of enquiry is appropriate. The single authority referred to for CE according to Korhonen et al (2018b) "*is Kenneth Boulding's work on the* "*spaceship earth" (1966), or Georgescu-Roegen's work on thermodynamics in economic systems (1971) or the already now often cited Scientific American article "Strategies for Manufacturing" by Frosch and Gallopoulos (1989*)". However, from these points of departures, a progressive competition takes place, while "the original exemplar's work is sustained". As different approaches, Korhonen et al (2018b) refers to e.g. ecological economics, industrial ecology, cradle-cradle design, restorative economy or performance economy, biomimicry, ecoefficiency, resilience science, natural capitalism, cleaner production etc. All these agree on the importance of material cycles and regenerative use of resources although using different concepts and methodologies.

The research strategy

The analytical strategy in this paper is to conceptualize the understanding of CE-related structural couplings – first, regarding how matter and materiality is structurally coupled to social systems. Second, by digging deeper into the process of the structural coupling of organizational networks – eventually using digitalization – to enhance coevolution of structure and the semantics of CE as feedback mechanism. Third, the CE is analyzed in front of the multicontextuality as to address the concept as a general sustainability concept.

Below, we will briefly explain the Luhmannian concepts of semantics versus structure, as well as systemic transition and rearrangement of structural couplings.

Semantics versus structure – a complicated co-evolution

For Luhmann semantics consists of various vocabulary sets and groups of ideas that have been developed historically to make communication plausible (Luhmann, 1980, p. 19). According to Andersen (2011), meaning expresses specific operations, whereas the concept of semantics expresses condensed and generalized forms of meaning available to communicative operations. The concept of semantics relies on a distinction between meaning and condensed meaning. In the case of CE, different variations of the concept, as explained above, is condensed in the semantics of CE, and made available for communication.

Luhmann analyzed the distinction between societal structure and semantics and studied their co-evolution (Luhmann 1980, 1981, 1989, 1998). This distinction enables semantics "to act upon the society as if from outside" (Luhmann 1998, p. 48). Semantics not only reflect the current societal structures but also develop and test new ideas, models, or patterns. However, according to Luhmann (1998:40-41) a new semantics complying with the requirements of the new structures can only evolve if there is enough experience on the new societal conditions. For CE, this entails that enough structural transformation of society already has taken place for this semantics to evolve, even though a major structural transformation has not yet taken place.

Semantics play a role in communication in all types of social systems: interaction systems, organization systems and function systems. A complicated co-evolution of systems, communication, and semantics takes place (Andersen, 2011) in transformation processes, underlining the paradox of the chicken-and-egg problem, in which also trust and power is part (Neisig, 2017).

The CE, systemic transition, and rearrangement of structural couplings

In a complex polycentric context, a systemic transition (Assche et al., 2009) requires several social (and psychological) systems to change or co-evolve their inner representations of each other. This is the case if communication is about closing the loops based on the CE. This co-evolution is caused by what Luhmann terms 'structural coupling' (Luhmann, 2012). This refers to the way in which operationally closed systems interact with each other. Two systems are structurally coupled when they become dependent on one another for the perturbations used in their own ongoing autopoiesis or operations. One system drags irritations from another system to continue its own operations. One may question if social systems may structurally couple with entities that are not social systems. This is a relevant question regarding CE, as this semantics relate to matter and energy. Structural coupling, according to Luhmann, describes a procedure in which systems can connect to non-systems and the environments of systems through a medium.

> "…the coupling between system and environment concerns only structures and, as the case may be everything in the environment that is relevant to these structures… the structural coupling does not interfere with the systems' autopoiesis….Structural couplings can take all possible shapes as long as it is compatible with the systems autopoiesis. The emphasis is on compatibility… ….couplings are highly selective. Something is included and something else is excluded. What is excluded may very well affect the system causally, but only negatively. In contrast, in the domain of structural coupling, possibilities are stored that can be used by the system and be transformed into information…" (Luhmann et al, 2013, p. 85).

The concept of structural couplings is highly relevant for the CE. The semantics of the linear economy does not enhance structural coupling between, design and production companies and the end-of-product-life (=waste), whereas the CE semantics enhances structural couplings of organizational networks for closed loops taking responsibility of the totality of the material and energy flow.

In the next section we will discuss how matter and materiality may structurally couple with social systems and enact a metabolism with nature.

3. The CE, a social metabolism with nature and how matter and materiality may structurally couple with social systems.

Materiality and social systems

To understand CE in a social systems perspective, requires a more precise understanding of how matter and materiality is perceived by social systems theory as well as the media and forms through which social systems, matter and materiality may structurally couple.

Several different approaches to understanding the relationship between nature and society have a system theoretical foundation. However, what distinguishes the Luhmannian thinking is, that there is *no direct* coupling of society to any physical, chemical, or biological entity (Luhmann 1997, p 114). A critic of the social systems theory, on the other hand, has been the lack of explicit dealing with an understanding of matter and materiality. This critic has been rebuffed by different Luhmannian scholars e.g. Overvijk (2019). Overwijk (2019, p. 1134) states, that dealing with matter only appears as a deep problem if one is dealing with the question of "What is?"' rather than "What is society?". Valentinov (2013) points to Luhmann's understanding of "the world society" having an ecological environment (Valentinov, 2013, p. 319, Luhmann, 1982). This also shows, Luhmann's acknowledgment of the environment of the world society. Overwijk (2019, p. 1134) further states, that: "*it is precisely this social distinction that respects matter as an autonomous force. Putting matter in the environment of society protects the agency of matter from a reduction to the social system*."

By a Luhmannian lens, the perception of direct interaction, thus, needs to be replaced by the concept of structural coupling. Material components (human bodies and their artifacts) do not belong to social systems, which are constituted only by communication. What ties material components produced by humans to social systems are the medial relations between matter and communication organized through symbiotic-symbols, as explained by Luhmann (2012: 227–29) and Overwijk (2019, p. 1134).

According to Overwijk (2019, p. 1134) material-semiotic structural couplings (Luhmann, 2012: 227–29) refers to "symbiotic symbols" that organize the medial relations between matter and communication, like perception in science, sexuality in love, needs in the economy, and physical force in politics. These symbiotic symbols are always object[s] of cultural interpretation.

The modern society as described by Luhmann (2012 [1997]) is highly differentiated social systems such as interaction systems, organizations and function systems. Each of these systems may structurally couple with matter and materiality in different ways through symbolic media.

Function systems uses symbolically generalized communication media, such as power, money, scientific truth, educational credentials etc. Luhmann called these kinds of media "success media", as they motivate for the intent of the communication to succeed, which may couple to matter and materiality:

> In the economy, for instance, money is selectively connected with property in a way that sellers and buyers can both anticipate (in the form of a price). In education, grades can be selectively associated with the work of students in a manner that makes sense to both teachers and students (Lee et al, 2010).

For CE this entails, that success media such as money through the form of different pricing schemes may shape the way in which the different CE business models make sellers and buyers anticipate property and thereby needs and expectations. Power may through the political system enforce measures onto the market, and scientific trues may enhance the perception of the system-environment relation.

Organization systems are decision-making machines, using decision communication based on decision premises. However, they are programmable and reprogrammable decision machines (Roth, 2014), that may have preferences for different types of codes from function systems conveyed through different types of success media. For CE this entails that the decisions premises through an evolutionary change process in each organization may be reprogrammed according to the CE semantic. Decisions are coupled to psychic systems, which is one of the structural couplings best accounted for in Luhmanns theory (2012 [1997]). However, decisions may also through symbiotic-symbols couple matter and materiality e.g. the human body, technology, or materials such as buildings, raw materials etc. These matters and materialities are structurally coupled to organization systems, not part of them. Decisions based on decision premises may shape the flow of matter and energy according to the CE; but as matter and energy cannot be reduced to the social system (Overwijk 2019, p. 1134), it so to say has its own agency (=material conditions), which creates expectations (=structures) in the organizational system. Organization and materiality thus shape one another.

Interaction systems *embody* communications: '*they conceive of themselves as face-to-face interactions and use the presence of persons as boundary-defining device'* (Luhmann 1987, 114). As noted by Chettiparamb (2020) for Luhmann '*everything that happens, happens now*' (Luhmann, 2004, 131). Thus, Luhmann maintains the importance of 'presence' in interactions, however, writing and printing make it possible to withdraw from interaction systems and communicate with far-reaching societal consequences. In that sense Luhmann acknowledge dissemination media.

While interaction systems presuppose presence in Luhmanns theorizing, the materiality on which digital media are resting may change, how we should think about interaction systems, in the age of widespread online interactions, which is not limited to dissemination, but also embraces *online synchronous communication* by which persons *interact immediately,* but in a medialized structured way. For CE this entails, that bringing people physically together (with flow of matter and energy consequently), may change based on the CE as to reduce the flow of matter and energy.

Matter and materiality, thus, are coupled to all three types of social systems, and all three types of systems should be considered in an understanding regarding generating sustainability-enhancing systemic feedback.

Enactment of metabolism between social systems and nature - a four-layered structural coupling

Luhmann's thinking has also influenced The Vienna School of Social Ecology as a science. Based on Luhmann, as described by Haberl et al (2016), it is acknowledged, that the human body is not part of social systems but is the most immediate interface between the social and material realm. Haberl et al (2016) refer to Luhmann (1997, p.114) stating, that society is structurally coupled exclusively to the cognitive systems of the individuals. These cognitive systems and the social system are mutually interdependent in that the existence of one is the precondition of the other's autopoiesis. Here, they further refer to Lippuner (2011, p 312) and state that, the two systems are mutually coupled because each uses the other as a means of selection (and thus complexity reduction) in the common medium of language. Hence, society "acts" through the human body by way of a three-stage structural coupling: communication-consciousness-perception-body (Lippuner 2011, p. 311).

Neither social systems nor psychic systems, but the human bodies as living systems are interacting directly with matter and energy. Socio-Ecology is besides Luhmannian thinking, also inspired by Marx's concept of metabolism and the process of labor.

Marx (1976, 283) writes:

> Labor is, first of all, a process between man and nature, a process by which man, through his own actions, mediates, regulates, and controls the metabolism between himself and nature. He confronts the materials of nature as a force of nature. He sets in motion the natural forces which belong to his own body, his arms, legs, heads, and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement, he acts upon external nature and changes it, and in this way, he simultaneously changes his own nature (Marx, 1976, 283).

According to Marx (1976) the labor process is a purposeful activity aimed at the production of use values. That which is produced can either be useful in supporting human existence and so have a "use value" or it can be traded and attain an "exchange value". The latter value presupposes the former. Labor-power may also be traded as a source of livelihood. As trading through a Luhmannian lens refers to the economic system, the labor-power is through firms as organizations coupled to money as success medium, and the economic system as function system – and decided upon through the contract making an employee a member of the organization.

Inspired by Marx's concept of metabolism, De Molina and Toledo (2014: 87) writes, that "*Marx laid the foundations for the future construction of a socioecological theory, which given the severity of the present crisis has become an urgent need and the main challenge of scientific reflection".*

According to Foster (1999,2000), who coined the term, metabolic rift, metabolism is Marx's "*mature analysis of the alienation of nature*" (Foster, 2000). The notion of the metabolic rift (Foster, 1999, 2000), is very similar to the Luhmannian understanding of a precare system-environment relation (Valentinov 2013,2014). The metabolic rift interpreted to a Luhmannian understanding is the set of flows of materials and energy that occur between nature and the human bodies as living and psychic systems structurally coupled with social systems, though, society as a social system is only able to understand these structural couplings through function systems such as science, education, media, economy, religion, etc.

The suggestion in this paper, is to understand the structural coupling between nature and social systems through a three-stage structural coupling: communication-consciousness-perception-body (Lippuner 2011, p. 311) and then the fourth stage: through the process of labor a metabolism with nature takes place.

This suggestion is not far from, the suggestion made by Valentinov (2017a) and Assche et al. (2017). Assche et al. (2017) bring up livelihoods which '*can be understood as a direct experience of the socio-ecological system in a community as well as a possible fit between a social and an ecological system*'. Valentinov (2017a) elaborates, that from a systems-theoretic perspective, livelihoods embody the ideal of the generic sensitivity to the environment beyond the limits imposed by the systemic operational closure and complexity reduction. However, neither Assche et al (2017) nor Valentinov (2017 a,b) explain exactly, how this sensitivity comes about.

The four-layed structural coupling may explain *how* the concept of "livelihood" is providing this sensitivity despite of the limits imposed by the systemic operational closure (Valentinov 2017a) and how social systemic structures are "*called upon to make the functional imperatives sustainable in the outer environment"* (Valentinov 2019). It thus explains, the structural couplings in play if the moral based CE semantics should become a sustainability-enhancing feedback for the emergent reprogramming of organizations (Roth 2014, Roth and Schütz,2015), in which other than the economic function system may increasingly be valuated in managerial decision-making.

Ways in which the CE may enhance social systems sensitivity towards the environment.

Inspired by Boulding (1984) and Valentinov (2013), one may assume that in economic terms, the reason why organizations and networks of organizations based on the CE, are reducing the organizations' internal complexity and enhancing their sensitivity towards the environment, is, that externalities of the economy are internalized through the CE.

Inspired by (Luhmann 1997, p. 603 as cited by Valentinov,2013, p.319) one may understand the development of the CE semantics as a form of "horizontal governance", that may lead to a coordination reducing the degrees of freedom' of functional systems (e.g. the economy), and thereby lowering the probability to overstrain society's environments' carrying capacity.

The semantics of CE may also be a suggestion for how to repair (or reduce) "the metabolic rift" (Foster, 1999, 2000) – but only if the semantic is transformed into widespread structures (expectations) on how to organize the process of labor accordingly. Therefore, measuring the metabolism and the circularity of matter and energy in a scientific way, and using this as a feed-back communication "irritating" social systems and creating a structural coupling of the Socio-Ecology as a science and specific social systems, may enhance social systems sensitivity towards the environment. Recent research demonstrates strengths and weaknesses of socio-metabolic research (Haberl et al, 2019). They provide insights on patterns, drivers, systemic feedbacks, and sustainability implications of resource use from different angles. However, efforts to explicitly link the metabolism to e.g. social systems theory, could be strengthened. One way to do that, could be for social systems to use the scientific mapping of the metabolism as feedback "irritating" social systems change processes. Socio-Ecology research is so far performed with static data and classic methods, making the research historic (reactive). Haas et al (2020) shows the circularity of the matter and energy in a timeline 1900-2015. The decline in circularity has been much faster in certain periods of time than in others, and the huge stock of material in buildings, infrastructure and machines (which now need to be maintained) has a huge impact on the decline of the material and energy circularity worldwide. In the future, digitalization may enable a dynamic and almost real-time metabolic measurements, and if such scientific measurements are structurally coupled to relevant social systems, they may allow for enhancing the social systems reflexion on their relation with the outer environment as a sustainability-enhancing feedback mechanism, and as suggested by Valentinov (2013,2014) motivate a sustainability-complexity trade-off.

However, for the CE to coevolve with structure, measurements as feedback communication will not provide the change-process. Strategic decision-making is required in organizations, which is a paradoxical and evolutionary process and the coupling of organizations into organizational polycentric networks needed to close the loop in the CE may encounter difficulties and instability caused by the operational closure of organizational systems. This is to be accounted for in the next section.

4. Why structural changes related to the CE is slow, - strategic decisions in organizations, the difficulties of structural couplings of organizational networks, and the paradox of digitalization

The CE and structural couplings of organizational networks

As stated by Antikainen et al (2018) the idea of the circular business models is, that not one company closes the loop, but that business ecosystems (coupled polycentric networks of organizations) may do. Therefore, networking and collaboration with stakeholders but also new partners are needed in enabling circular business models.

This means, that circular business models rest on coupling of organizational networks. Polycentric networks are by Teubner (1993) seen as an emergent way of mitigating some of the effects caused by the highly differentiated modern society. Coupling of organizations in a CE business network is such an example.

Theoretically, Teubner (1993) defines a polycentric network, as higher-order autopoietic systems, to the extent that they set up emergent elementary acts ('network operations') through dual attribution, and link these up in a circular fashion into an operational system (Teubner, 1993:49). It is the dual pursuit of the individual (organizational) and collective (network) goals, that Teubner portrays as a polycentric or multi-polarity characteristic of the unified network (Teubner, 1993:51).

As described by Neumann (2011, 2012) and Neisig (2020) the structural coupling of a polycentric network requires new layers of abstraction e.g. collaborative systems, heuristics, and shared semantic reservoirs. Neuman et al (2011) and Neuman (2012) point to the need for a collaborative system for business networks to couple, and Neisig (2020) argues, that for polycentric organization-networks and their collaborative system to form, a shared semantic reservoir (heuristics, tools, procedures, language, etc.) with a horizon spanning across the entire network also needs to emerge. This is not something that easily comes about. Regarding the CE it may e.g. be standards or declarations for certain residuals, specific CE certifications, controlling procedures, transparency and accountability.

To understand the difficulties for polycentric organizational networks to structurally couple, the Luhmannian conceptualization of organizations as self-reproducing social systems of decision communications (Luhmann, 2018 [2000]) is important. Nassehi (2005) termed organizations as decision machines (Nassehi, 2005) – and Roth (2014) calls organizations *programmable and reprogrammable multifunctional* decision machines. Thus, these decision machines may reprogram themselves, if they observe a sustainability-enhancing feedback like the semantics of CE. However, decision communication is distinct from other types of communication as it contains information about other not selected ways of communicating as well as justification of the selection. Decisions, thus, communicate the paradox of being undecidable, as famously stated by Foerster

(1992, p. 14), "*Only those questions that are in principle undecidable, we can decide*" – everything else would be mere calculation. Rasche and Seidl (2017) explain the paradoxical foundation of strategic decisions, that cannot be solved logically as they rest on conditions of double contingency. This is also the case for the CE, which requires participation in networks to close the loop. Here, decision-making rests on conditions of double (or multiple) contingency as network-participants decisions are mutually de-/potentializing conditions for new CE decisions.

Rasche and Seidl (2017) also account for the contextual 'emptiness' of strategy concepts, as an organization cannot receive any direct input from another organization. It will always reconstruct the meaning of a newly adopted strategic concept and select meaning based on the decision premises of the organization retained in the organizational program (Seidl and Mormann 2015, Luhmann 2018 [2000]). Therefore, a long chain of preconditions are required for business ecosystems based on the CE to emerge: both the reconstruction of the concept of CE for the particular organization and network, as well as the emergence of a shared semantic reservoir specific for and spanning across the network and the generation of a collaborative system observed by the structural coupled organizations. Also, each of them needs to select and retain an inner representation of the collaborative system and adjusted their own decision premises. Thus, this is a complex evolutionary process of strategic change.

CE, digital technologies, and artificial intelligence – sustainability-enhancing or complexity-maintenance feedback?

However, making CE mainstream, requires more than a shared semantic reservoirs and collaborative systems based on semantics carrying moral communication to structurally couple organizations. Wilst and Berg (2017) describes several barriers as to why CE is not more proliferated. A key challenge in this process lies in effectively generating, collecting, processing, and making available the volume of information about the material composition of each individual product, its use patterns, its location within the waste system, etc. All of this is necessary to establish functioning markets and cycles in the next stage. Wilst and Berg (2017, p.1) writes:

> Despite the recent interest in a circular economy, recycled materials are being fed back into production processes at volumes that are far below what is possible. If this system were to be improved, loss of value, dependence on volatile commodity markets, lower resource productivity, and externalities in the form of environmental pollution could be avoided. A

drive towards digitalization in industry and the waste management sector could make this happen.

Thus, digitalization could be a tool enabling and empowering organizations for such a transformation and creating coercion for changed decision premises in organizations and proliferate a semantic reservoir across a polycentric network making it shared, and hereby stabilize the network.

Pagoropoulos et al (2017) have conducted a systematic literature review to examine the intersection between digital technologies, digital capabilities and the CE. They have grouped the technologies that were discussed in the literature, according to the three architectural layers: 1) Data collection 2) Data integration and 3) Data analyze. See table 1.

However, Luhmann (2018 [2000], p.304) writes: *"Technology can be very formally defined as the tight coupling of causal elements, no matter what the material basis for this coupling."* In this case, technology may not help a sustainability-enhancing feedback, as it conveys a stiff semantic reservoir. If the semantic reservoir is flexible to react to the environment, it serves as a reservoir for sustainability-enhancing feedback, if it is too stiff it serves as complexity-maintaining feedback (Valentinov 2014, Neisig 2020).

Furthermore, Luhmann writes (2018 [2000], p.308): *"Technical systems can be described as allopoietic systems, which are exogenously controlled, and which cease to operate when impulses cease".*

One may dispute both citations, in so far as it concerns new forms of Artificial Intelligence (AI) based on neural networks abstracting and making sense very similar to the human brains (Neisig, 2017). Maybe such forms of AI can also compensate for the need of tight couplings regarding computerization, as systems may "learn" from "experience" and create "expectations". Furthermore, AI-systems may be capable of communicating in very similar ways as social systems.

Whereas current machine-learning systems typically operate in isolation, people often work in teams (interaction systems) to collect and analyze data. New machine-learning methods may be capable of working collaboratively with humans to jointly analyze complex data sets, using humans to draw on diverse background knowledge to generate plausible explanations and suggest new hypotheses, and we may see new models of "interacting" (= structural couplings of) machine learning, organizations as well as biological systems. Also, machine-learning systems are increasingly taking the form of complex collections of software that run on large-scale parallel and distributed computing platforms and provide a range of algorithms and services to data analysts (Jordan and Mitchell, 2015).

It is not difficult to imaging, how also social-ecology measures of the metabolism may be traced dynamically in real-time as instant feedback to social systems enabling reflexion on compliance with the CE, and even generating proposals for improvements.

As the complexity of the machine-learning systems increases, machine-learning researchers try to formalize the relationships of resources, aiming to design algorithms that are provably effective in various environments and explicitly allow users to express and control trade-offs among resources (Jordan and Mitchell, 2015) e.g. costs versus reduced metabolism, allocation of scares resources e.g. biomass, etc. The control of these trade-offs may become crucial sustainability enhancing feedback, but it may also be imbued by blind spots (e.g. externalities that are not included in costs) creating a renewed complexity-maintaining feedback. Thus, big data analytics, machine learning, and AI may possibly create even more complexity, as more and more complex big data analytics, machine learning, and AI systems may create emergent phenomena and side-effects e.g. shifts in the job-landscape including certain types of skills and excluding others, environmental impacts of RFIDs (radiofrequency-ID's used for track and trace), huge energy consumption of digital equipment ect. Human confidence may not be able to predict such emergence and the selection of trust as a way of reducing complexity may be challenged or blind.

As a paradox, big data analytics, machine learning, and AI seem to decrease complexity and create a sustainability-enhancing feedback and simultaneously create even more complexity and by that create a complexity-maintenance feedback due to blind spots. More paradoxes related to CE are to be elaborated in section 5.

5. The multicontextuality – a critical discussion of the limitations of the CE as a sustainability-enhancing systemic feedback

Blind spots of the CE regarding the multicontextuality – semantics and tools embracing more of the complexity.

In this section the focus is to discuss possible new blind spots created by a widespread selection and retention of CE as semantic and structure.

Roth and Valentinov (2020) argue for a polycontextual approach for striving towards sustainability:

> If the Luhmannian vision is accepted, then ecological economics can be said to privilege the observational perspective of natural sciences. The unfortunate consequence of this privileging is the underestimation of a broad range of multidimensional sustainability risks which are foregrounded by the numerous alternative observational perspectives which are just as legitimate. (Roth and Valentinov, 2020, p. 1)

Based on Luhmann's notion of function systems Roth and Schütz (2015) have accounted for exactly ten function systems (politics, art, science, religion, law, education, health, economy, sport, and media). Roth and Valentinov (2020) argue that in a polycontextual society the notion of environment needs to be understood in pluralis, as a multitude of social systems each bringing forth their own environment, and they suggest a scanning tool based on the ten Luhmannian function systems (Roth and Valentinov, 2020).

The risk and danger in not acknowledging the needs for such a broad scanning may be illustrated by the case of Huangbaiyu, a Chinese eco-village based on Cradle-to-Cradle principles (Neisig, 2014), which is one of "the schools of thought" related to the CE heuristic. Many of the original ideas of the Huangbaiyu eco-village did not come true. E.g., none of the houses faced south as originally planned to become efficient for solar energy, because the building contractor changed orientation to fit Feng Shui. Inexplicably, the new houses got garages, although none of the villagers could afford a car (Toy, 2006). In Huangbaiyu most of the farmers complement their livelihood from the sale of maize, small flocks of sheep or pigs, and small gardens for vegetables (Toy, 2006). The income farmers stood to lose with less room for additional crops did not appear to be part of the planners' calculations. Even if the houses were more affordable and people's incomes increased, they would not want to spend the money on new houses. They would rather send their daughter to college, get surgery for a grandmother, or open a small shop. The project was based on a big assumption that people wanted a new house (Toy, 2006).

A multicontextual scanning tool as suggested by Roth and Valentinov (2020), would have revealed religious meaning for the orientation of housing, need for education and health as well as economic issues. Instead, the project was narrowly focused on show-casing the ecologically inspired Cradle-to-Cradle eco-village (which is in line with the CE heuristic).

Roth (2019) suggests that a better success with the higher goals of environmentalism. could be obtained if environmentalists focus not on problems of capitalism and growth, but on those non-economic aspects of social life that can be grown instead. CE is neither a de- or post-growth semantics but intend to decouple economic growth and negative consequences for the natural environment, but it does not focus observations on broader aspects of social life. This lack has also been address in parts of the CE literature, trying to include economy and social aspects in the concept e.g. Korhonen (2018a), but the most used definitions exclude other aspects than matter and energy flow.

Expanding the dimensions to look for, when striving for sustainability, and develop more advanced "bottom lines", e.g. expanding Elkington's (1997) triple bottom lines to include accounting for all 17 UN Sustainability Development Goals (SDG) has been addressed by Rendtorff (2020). Also, the OECD has suggested to not only account for GDP but using other indexes such as the Better Life-index (OECD, 2020). Other relevant indexes are the Human Development Index (HDI) used by UNDP (Stanton, 2007) and the Social Progress Index (SPI) published by the nonprofit Social Progress Imperative (Porter et al 2017). The SPI is aligned with measuring the SDG's, and by Harberl et al (2019) the socio-metabolic measures are mapped against the SPI.

A paradox: sustainability-enhancing feedback instantly also creates complexity-maintaining feedback.

Acknowledging, that sustainability is about much more than climate, circularity and "footprint" reveals the vast complexity in striving for sustainability. Heuristics, tools, and shared semantics may be expanded to embrace more of the complexity, as illustrated by the Luhmannian based multi-environmental scanning approach (Roth and Valentinov 2020) and the different measurement indexes. However, this may also increase the complexity and make it even more difficult for business ecologies to couple in polycentric networks i.e. to create shared semantic reservoirs and collaboration systems, that encompasses a broad perspective on environments *in pluralis.* This multicontextual perspective also raises the question: when is sustainability-enhancing feedback sufficient?

Digitalization may help to handle very complex sustainability-enhancing feedback. Blockchain technology, big data, and AI may support keeping track of multiple parameters, broaden the perspective of collaborative systems, enhance human cognition, and even facilitate organizations' decision-premises to become multifunctional. However, blind sports and paradoxes are unavoidable even as scanning approaches, tracking, and analytical tools, shared sematic reservoirs, collaborative systems, decision-premises are improved to better comprehend and reduce the vast complexity. Paradoxes are unsolvable because they are the unity of the marked and unmarked in any distinction (Luhmann, 2002: 88). Luhmann describes how any distinction can be paradoxified by crossing from the marked to the unmarked part of a distinction (which creates reentries), and deparadoxified by shifting observation to a position from which the unity may be seen – however shifting position takes time, and will always create a new distinction, that can be paradoxified. He describes the situation in a modern differentiated society:

> Functional differentiation requires polycontextural hypercomplex complexity-descriptions without unifying perspectives. Society remains the same but appears as different depending on which functional system (…) describes it. The same is different. (Luhmann, 2002: 89).

This means, that moral based heuristics, tools, semantics, etc., that enables the process of moving to a higher level of observation, enabling new types of structural couplings, also over time creates "new environments" – and thereby new paradoxes. For Luhmann, the very existence and autopoiesis of a system is based on (the paradox of) the unity of the distinction between the system and its environment. Therefore, new paradoxes will be created as soon as new polycentric networks or higher-order systems emerge. New ways of reducing the complexity by even more sophisticated methods that allow for more sophisticated structural couplings will end up producing a new complexity. This may point to the paradox that: sustainability-enhancing feedback instantly also creates complexity-maintaining feedback – as it seems to be the unity of two sides in a distinction. Sustainability, therefore, will never become a steady state, but always a wrestling of different perspectives.

6. Conclusion

In this section we will conclude on CE's prospects to become a sustainability-enhancing feedback mechanism potentializing an evolutionary rearranging of structural couplings, and if it may encounter limitations as a general approach for a sustainable development.

In section 2 we explained how the CE relates to key concepts as semantics, structure, structural couplings and how rearranging structural coupling is an evolutionary process in which semantics are coevolutionary. We also explained the research strategy as built in three stages: 1) The first enquiry was how matter and materiality are structurally coupled to social systems. 2) The second enquiry was digging deeper into the process of the structural coupling of organizational networks needed to close the loop for a CE based structure – eventually using digitalization. 3) In the third enquiry, the structural couplings enhanced by the CE semantics was analyzed in front of the multicontextualiy.

In section 3 we unfolded a more precise understanding of how matter and materiality is perceived by social systems theory (Valentinov, 2013, Luhmann, 1982, 1997, Overwijk 2019) as coupled through communication of symbiotic-symbols and symbolic media. The distinction between society consisting of communication, and the environment, is what allows social systems to observe the environment, and simultaneously understand the outer environment to be different from society. The suggestion in this paper, is to understand the coupling between nature and social systems through a four-stage structural coupling: communication-consciousness-perception-body (Lippuner 2011, p. 311, Haberl et al, 2016) and then the fourth stage: through the process of labor a metabolism with nature takes place, which can be measured (as well as measurement of the circularity of this metabolism) (Haberl et al, 2019, Haas et al 2020) – and used as a CE feedback mechanism structurally coupled to and "irritating" relevant social systems' process of reflexion.

In section 4 we explained how CE as a semantic may facilitate the processes of creating the polycentric networks of organizational systems needed to close the loop and transition from linear to circular business models. However, this is not an easy process as organization systems are operationally closed self-referential decision-making machines and many contingencies may make structural couplings difficult. This explains why the proliferation of the CE is difficult as seen from a social systems theoretical perspective. Furthermore, making CE mainstream, requires more than strategic decisions, shared semantic reservoirs and collaborative systems (Foerster 1992, Luhmann 2018 [2000], Nassehi 2005, Roth 2014, Seidl and Mormann 2015, Rasche and Seidl 2017, Teubner 1993,2011, Neumann 2011, 2012, Neisig 2020), based on semantics carrying moral communication. A key challenge lies in effectively generating and distributing the vast amount of information required (Wilst and Berg, 2017, Pagoropoulos et al (2017). All of this is required to establish functioning CE markets and cycles in a broad scale. A practical advice, thus, is that digital support is needed for the CE to gain a major proliferation, and by increased digitalization it is also possible to move forward with using social-metabolism measures as sustainability-enhancing feedback (input for reflexion) "irritating" relevant social systems.

However, the way in which Luhmann (1927-1998) understands technology, is rather "stiff" (Luhmann (2018 [2000]) and would not help a sustainability-enhancing feedback. Understanding technology as very formally defined tight coupling of causal elements, no matter what the material basis for this coupling is (Luhmann, 2018 [2000]), does not reflect the present or future AI. Based on neural networks, AI is able to "learn" from "experience" and create "expectations", and may become able to communicate in very similar ways as social systems. Thus, future digitalization may help CE to become a sustainability-enhancing mechanism but simultaneously also create new side-effects.

In section 5 we found that by the semantics of CE the multicontextuality (Roth et al, 2015, Roth 2019, Roth et al 2020) is ignored. Thus, it creates complexity-maintenance feedback towards those other environments. A practical advice is, that broader measures like e.g. coupling to the SPI (and the SDGs) and scanning tools as suggested by Roth and Valentinov (2020) will be needed to become a more general approach for sustainability. This will, however, increase the complexity and make structural coupling even more difficult.

For Luhmann, the very existence and autopoiesis of a system is based on (the paradox of) the unity of the distinction between the system and its environment. This points to the paradox of: sustainability-enhancing feedback that instantly also creates complexity-maintaining feedback – as it seems to be the unity of two sides in a distinction. Sustainability, thus, will never become a steady state, but always a wrestling between different perspective. A general theory of sustainability needs to take this into consideration.

Summing up on future research requirements, we will suggest more research into a Luhmannian understanding of digitalization, more research in how social systems theory, social-metabolism measures and broader measurements/scanning tools may become a more general sustainability-enhancing feedback mechanism relevant for social systems. We also recommend more research into understanding different perspectives and potential social side-effects of the CE.

References

Alhawari, O.; Awan, U.; Bhutta, M.K.S.; Ülkü, M.A. (2021) Insights from Circular Economy Literature: A Review of Extant Definitions and Unravelling Paths to Future Research. *Sustainability* Vol. 13 p.859

Andersen, N.Å. (2011) Conceptual history and the diagnostics of the present, *Management & Organizational History*, Vol. 6 No.3 pp. 248-267

Antikainen, M., Uusitalo, T., Kivikytö-Reponen, P. (2018), Digitalisation as an Enabler of Circular Economy,10th CIRP Conference on Industrial Product-Service Systems, IPS2 2018, 29-31 May 2018, Linköping, Sweden

Assche K.v., Duineveld M, Beunen R. (2009). Redefining transition management. *Wageningen University Working Papers in Evolutionary Governance Theory,* Vol. 9 pp. 1– 14.

Assche, K.v., Beunen, R., Duineveld, M., & Grezmacher, M. (2017). Power/knowledge and natural resource management: Foucaultian foundations in the analysis of adaptive governance. Journal of Environmental Policy and Planning, this issue.

Boulding, K. (1966) The Economics of the Coming Spaceship Earth. In Jarrett, H. (ed.) *Environmental Quality in a Growing Economy: Essays from the Sixth Resources for the Future Forum.* Baltimore: Johns Hopkins Press, pp. 3–14.

Boulding KE. (1984). The organizational revolution: a study in the ethics of economic organization. Westport (CT): Greenwood Press.

Chettiparamb, A. (2020) Autopoietic interaction systems: micro-dynamics of participation and its limits, International Planning Studies, 25:4, 427-440

Churchman, C.W. (1968), *Challenge to Reason*, McGraw-Hill, New York, NY.

Churchman, C.W. (1979), *The Systems Approach*, Dell Publishing, New York, NY.

Churchman, C.W. (1982), *Thought and Wisdom,* Intersystems, Seaside.

CIRAIG (International Reference Centre for the Life Cycle of Products, Processes and Services), (2015). *Circular Economy: A Critical Literature Review of Concepts*. Polytechnique Montréal, Canada.

COM (European Commission) (2014). *Towards a circular economy: a zero waste programme for Europe*. Communication From the Commission to the European Parliament. The Council, the European Economic and Social Committee and the Committee of the Regions, Brussels (EN).

COM(European Commission) (2015). *Closing the Loop - An EU Action Plan for the Circular Economy.* Communication From the Commission to the European Parliament. The Council, the European Economic and Social Committee and the Committee of the Regions.

De Molina, M. G., and Toledo, V. M. (2014). The social *metabolism. A socio-ecological theory of historical change* (Vol. 3). Springer, Dordrecht.

Elkington, J. (1997) *Cannibals with Forks: The Triple Bottom Line of the 21st Century Business*. Capstone, Oxford.

Ellen MacArthur Foundation (EMAF), 2012. *Towards the Circular Economy*, Report vol. 1.

Ellen MacArthur Foundation (EMAF), 2013. Towards the Circular Economy. EMAF, 2013 (London, UK).

Ellen MacArthur Foundation (EMAF), SUN, McKinsey & Co, 2015. *Growth Within: A Circular Economy Vision for a Competitive Europe.*

Ellen MacArthur Foundation (EMAF) (2015) *Towards* a *Circular Economy*: *Business Rationale for an Accelerated Transition,* Ellen MacArthur Foundation, available at: https://www.ellenmacarthurfoundation.org/assets/downloads/TCE_Ellen-MacArthur-Foundation-9-Dec-2015.pdf (accessed 5 December 2020).

Foerster, H. v.(1992), "Ethics and second-order cybernetics". *Cybernetics and Human Knowing, Vol.1 No.1 pp.* 9–19

Foster, JB (2000) *Marx's Ecology: Materialism and Nature*, New York: Monthly Review Press,

Foster, JB (1999). *"'Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology'". The American Journal of Sociology, 105 (2): 366–405*

Frosch, D., Gallopoulos, N. (1989). Strategies for manufacturing. Scientific American Vol. 261 No.3, pp. 94–102

Gallie, W.B. (1956). Essentially contested concepts. *Proceedings of the Aristotelian Society*, Vol. 55 pp. 167-198

Geissdoerfer, M., Savaget, P., Bocken, N., and Hultink, E. (2017). "The Circular Economy – A new sustainability paradigm?", *Journal of Cleaner Production,* Vol.143 No.1, pp. 757-768.

Georgescu-Roegen, N. (1971). *The Entropy Lawand the Economic Process*. Harvard University Press, Cambridge, MA.

Haas, W., Krausmann, F, Wiedenhofer, D., Lauk, C., Mayer, A. (2020), Spaceship earth's odyssey to a circular economy - a century long perspective, *Resources, Conservation & Recycling* Volume 163, p. 105076

Haberl, H.; Fischer-Kowalski, M.; Krausmann,F. and Winiwarter, V. (Eds) (2016) *Social Ecology. Society-Nature Relations across Time and Space*. Springer, Dordrecht.

Haberl, H., Wiedenhofer, D., Pauliuk, S., Krausmann, F., Müller, D.B., Fischer-Kowalski, M. (2019) Contributions of sociometabolic research to sustainability science. *Nature Sustainability* Vol. 2, pp.173–184 .

Jordan MI, Mitchell TM (2015). "Machine learning: Trends, perspectives, and prospects", *Science* Vol. 349, pp. 255–260.

Kirchher, J., Reike,D., Hekkert, M. (2017) Conceptualizing the circular economy: An analysis of 114 definitions, *Resources, Conservation & Recycling* Vol. 127 pp. 221–232

Korhonen, J.,Honkasal, A. and Seppälä, J. (2018a) Circular Economy: The Concept and its Limitations, *Ecological Economics* 143 pp 37–46

Korhonen, J., Nuur, C., Feldmann, A., Birkie, S.E. (2018b) Circular economy as an essentially contested concept, *Journal of Cleaner Production* Vol. 175 pp. 544-552

Lee, D.B., Goede, J. and Shryock, R. (2010) Clicking for friendship: social network sites and the medium of personhood, *MedieKultur* 49, 137-150

Lippuner, R. (2011). "Gesellschaft, Umwelt und Technik. Zur Problemstellung einer „Ökologie sozialer Systeme" ". *Soziale Systeme. Zeitschrift für soziologische Theorie, Vol. 17 No.* 2, pp. 308–335.

Luhmann,N. (1980,1981, 1989), *Gesellschaftsstruktur und Semantik. Studien zur Wissenssociologie der modernen Gesellschaft*, bd. 1-3. Frankfurt am Main: Suhrkamp.

Luhmann N.(1982). The world society as a social system. International Journal of General Systems, Vol. 8 No 3 pp.131-138

Luhmann, N. (1987). "The Evolutionary Differentiation Between Society and Interaction." In The Micro-Macro Link, edited by J. C. Alexander, B. Giesen, R. Munch, and N. J. Smelser, 112–131. Berkeley: University of California Press

Luhmann, N. (1997). *Die Gesellschaft der Gesellschaft*. Suhrkamp, Frankfurt a.M (In English: Luhmann N (2012) *Theory of Society*. Stanford University Press, Stanford, CA)

Luhmann, N. (1998), Ideenevolution: Beiträge zur Wissenssoziologie, herausgegeben von André Kieserling, Suhrkamp, Frankfurt.

Luhmann, N. (2002) *Theories of Distinction*: Redescribing the Descriptions of Modernity. Stanford University Press. Stanford, CA

Luhmann, N. (2004). *Law as a Social System*. Translated and edited by K. A. Ziegert. Oxford : Oxford University Press.

Luhmann, N. (2018 [2000]) Organization and decision. Cambridge: Cambridge University Press.

Luhmann, N., Baecker, D., & Gilgen, P. (2013). *Introduction to systems theory.* Cambridge: Polity.

Marx, K. (1976) *Capital*. Vol.1. Vintage, New York, NY

May, S. (2007). "A Sino-U.S. Sustainability Sham*", Far Eastern Economic Review*, April 2007

May, S.(2008). "Ecological citizenship and a plan for sustainable development*", City* Vol. 12 No. 2. pp. 237-244.

May, S (2008-2009). "Huangbaiyu -The Project **-** the facts", available at: http://www.shannon-may.com/Huangbaiyu_Facts.html (accessed 5 December 2020)

Moreno and Charnley (2016) Can re-distributed manufacturing and digital intelligence enable a regenerative economy? An integrative literature review. Smart Innovation, Systems and Technologies, vol. 52, Springer: Cham, pp. 563–75.

Nassehi A., 2005, "Organizations as decision machines: Niklas Luhmann's theory of organized social systems". The Sociological Review. 53(1_suppl):178-191

Neisig, M. (2014), Transferring Methods to New Contexts, in Simonsen, J et al (eds): *Situated Design Methods,* MIT Press, Cambridge, MA, pp. 357-376.

Neisig, M., 2017, "Deep Learning in a hypercomplex third-order society - A spiral of paradox and deparadoxication"**.** Conference-paper for: EURAM, Glasgow 21.-24. June 2017 - Making Knowledge Work. Retrieved 2.1.2021: https://rucforsk.ruc.dk/ws/portalfiles/portal/67424052/Deep_Learning_in_a_Hypercomplex_Third_order_Society.pdf.pdf

Neisig, M. (in press 2020), "Social systems theory and engaged scholarship: co-designing a semantic reservoir in a polycentric network", *Journal of Organizational Change Management*

Neumann D., de Santa-Eulalia L.A., and Zahn E. (2011) "Towards a Theory of Collaborative Systems". In Camarinha-Matos L.M., Pereira-Klen A., and Afsarmanesh H. (eds) *Adaptation and*

Value Creating Collaborative Networks. 12th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2011, São Paulo, Brazil, October 17-19, 2011. Proceedings, Springer, Berlin, Heidelberg, pp. 306-313.

Neumann, D. (2012), *On the Paradox of Collaboration, Collaborative Systems, and Collaborative Networks*, paper presented at the 13th Working Conference on Virtual Enterprises (PROVE), October 2012, Bournemouth, United Kingdom. pp.363-373, available at: https://hal.inria.fr/hal-01520426/document (accessed 5 December 2020).

OECD (2020), *How's Life? 2020: Measuring Well-being*, OECD Publishing, Paris.

Overwijk, J.(2019) Autopoietic System*, Philosophy Today*, Volume 63, Issue 4

Pagoropoulos, A., Pigosso, D.C.A., McAloone, T.C (2017). "The Emergent Role of Digital Technologies in the Circular Economy: A Review", *Procedia CIRP*, Vol. 64, PP. 19-24,

Porter, M. E., Stern, S., & Green, M. (2017). Social Progress Index. Social Progress Imperative. Retrieved 11.marts 2021: https://www2.deloitte.com/content/dam/Deloitte/de/Documents/public-sector/Social-Progress-Index-Findings-Report-SPI-2017.pdf

Rasche, A. and D. Seidl, 2017, "A Luhmannian perspective on strategy: Strategy as paradox and meta-communication." Critical perspectives on accounting, 73: 101984

Reichel, A, (2016). "Postgrowth and Degrowth, Sustainability and postgrowth" Research blog, available at: https://www.andrereichel.de/2016/03/11/postgrowth-and-degrowth/ (accessed 5 December 2020).

Rendtorff, J. D. (2020). "Corporate citizenship, stakeholder management, and Sustainable Development Goals (SDGs) in financial institutions and capital markets". *Journal of Capital Markets Studies*, Vol. 4 No.1, pp. 47-59.

Roth, S. (2014) "The Multifunctional Organization: Two Cases for a Critical Update for Research Programs in Management and Organization", *Tamara: Journal for Critical Organization Inquiry,* Vol.12 No. 3, pp. 37-54

Roth, S., and Schütz, A. (2015). "Ten Systems: Toward a Canon of Function Systems". *Cybernetics and Human Knowing.* Vol.22 No.4, pp. 11-31

Roth, S. (2019), "Heal the world. A solution-focused systems therapy approach to environmental problems", *Journal of Cleaner Production*, Vol.216, pp. 504-510.

Roth, S., and Valentinov, V. (2020) “East of nature. Accounting for the environments of social sciences”, *Ecological Economics*, Vol.176, p. 106734

Seidl. D. and H. Mormann, (2015), “Niklas Luhmann as organization theorist”, in Adler, P., du Gay, P., Morgan, G., Reed, M. (eds.) Oxford handbook of sociology, social theory and organization studies: Contemporary currents. Oxford: Oxford University Press, pp. 125-157.

Stanton, E.A (2007). "The Human Development Index: A History". PERI Working Papers: 14–15. Retrieved 11. Marts.2021: https://web.archive.org/web/20190228191918/https:/scholarworks.umass.edu/cgi/viewcontent.cgi?article=1101&context=peri_workingpapers

Teubner, G. (1993), “The Many-Headed Hydra: Networks as Higher-Order Collective Actors”, in McCathery, J., Picciotto, S. and Scott, C. eds., (1993). *Corporate Control and Accountability: Changing Structures and the Dynamics of Regulations*, Oxford University Press, Oxford.

Teubner, G. (2011), *Networks as Connected Contracts*, Bloomsbury Publishing

Toy, M-A. (2006) “China's first eco-village proves a hard sell.” *The Age*, August 26. Available at: https://www.theage.com.au/world/chinas-first-eco-village-proves-a-hard-sell-20060826-ge307r.html (accessed 5 December 2020).

Ulrich, W. (1988), “Churchman’s ‘process of unfolding’ – its significance for policy analysis and evaluation”, *Systemic Practice and Action Research,* Vol. 1, pp. 415-428.

Valentinov, V. (2013) Corporate social responsibility and sustainability: insights from Boulding and Luhmann, International Journal of Sustainable Development & World Ecology, 20:4, 317-324.

Valentinov, V. (2014) “The Complexity- Sustainability Trade-Off in Niklas Luhmann's Social Systems Theory”, *Systems Research and Behavioral Science*, Vol. 31 No.1, pp.14-22.

Valentinov, V. (2017a) Materiality in natural resource management: a systems theory view, Journal of Environmental Policy & Planning, Vol.19 No.3, pp.323-326.

Valentinov, V. (2017b). Wiener and Luhmann on feedback: From complexity to sustainability. Kybernetes, 46 No.3, pp. 386–399.

Valentinov.V. (2019) “The Ethics of Functional Differentiation: Reclaiming Morality in Niklas Luhmann’s Social Systems Theory, *Journal of Business Ethics,* Vol.155, pp.105–114

Wilts, C. H., and Berg, H. (2017). "*The digital circular economy: Can the digital transformation pave the way for resource-efficient materials cycles*”. Wuppertal: Wuppertal Institut für Klima, Umwelt, Energie