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Re-founding organizational ontology for sustainability: the role of ecological accounting as a bridge between scientific and practical knowledge

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Abstract

Purpose - We are looking to identify what organizational ontology is adapted to integrate ecological issues into accounting and explore how this ontological focus can help building a shared understanding of organizations in the context of ecological crises, by bridging sciences.

Design/methodology/approach - We adopt a conceptual approach by unveiling the ontological presuppositions underlying some financial and socio-environmental accounting. A hypothetical case study is mobilized to illustrate how CARE ecological accounting relies on alternative assumptions about the organizational ontology.

Findings - Ontological presuppositions on organizations are related to the purpose of each accounting framework. Integrating the ecological responsibility of human activities into accounting demands to better consider the impacts organizations have on natural and social entities. “Relational ontologies” seem best adapted to such an understanding. Coupled with a process-based ontology from an extension of traditional accounting, natural and human capitals’ uses can be followed and managed.

Originality - Taking this ontological prism renews the role of accounting: ecological accounting structures and makes sense of information, is fed by and feeds other domain-specific ontologies (e.g. hydrology, climatology, pedology, law, economics). This enables conceptualization of organizational ontology as intrinsically related to these same ontologies. Only then can knowledge generated about organizational processes be rendered relevant in these domains.

Key words - organization ontology ; accounting ontology ; ecological accounting ; interdisciplinarity ; relational ontology ; Basic Formal Ontology ; natural capital

1) Introduction

A local community uses groundwater to provide a service of contemplation by storing it in an open-air basin. The water becomes exposed to environmental pollution and must be drained regularly. The groundwater is pumped, stored in the basin, then drained into the wastewater network.

As part of a renovation plan, the organization voluntarily decides to reduce the pumping of the groundwater for the same service, by creating swales and a filtering garden. The filtering garden makes it so that it is not necessary to drain the basin for sanitary purposes, therefore reducing the pumping of water.

Under the current existing accounting information systems, the only available information about this renovation plan is related to financial costs. Information regarding the state of the groundwater table or its quality, before and after usage, has no place and is thus irrelevant. It cannot be the basis for informed decisions.

If the necessity arises to reduce the financial budget that is destined to the project between 1) the development of a new service from this installation 2) the quantity of water 3) the quality of the water, we can hypothesize that there will be no solid ground for arbitration in favor of any one of these items.

Indeed, at the organizational level, there is no necessity to quantify impacts, thresholds and to orient or reorient activities if necessary. Regulations that give territorial thresholds exist at the level of the hydrographic basin; consequently, they are not adapted to any specific organization that provides goods and services which use water in their production process. This knowledge is not transposed at a smaller, organizational level and cannot be used as a basis for decision-making.

This case highlights a problem organizations may face if they wish to engage in “greening” their practices. Despite some existing regulations that set ecological thresholds, efforts made by organizations are not materialized in a homogenous information system which can make sense out of them. Thus, they cannot be accounted for, considered or rewarded. If the goal of organizations’ accounting information system (AIS) remains unchanged, there is no reason to believe that the finalities of their activities will. Indeed, organizational goals are consubstantial with the design of their AIS. Both are based on conventionally defined standards (Amblard, 2004). We hypothesize that in order to integrate ecological goals, standards and AISs will have to be adapted accordingly.

This raises the following question: what is accounting about? And if accounting is about organizations, what is an organization? This latter is an interrogation on organizational ontology.

Ontology refers to the being, to what is (what exists). As a branch of philosophy ontology “is the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality.” (Smith, 2004, p.1). The purpose of philosophical descriptive or realist ontology is to describe rather than explain reality. The results of such an ontological inquiry are not an explanation of the reality, rather mere “exhaustive classification of entities” which often corresponds to taxonomies (Smith, 2004; Lawson, 2004). Following Husserl, it so called “formal ontology” refers to a theory of shared aspects of reality and is domain neutral (Smith, 2004). Lawson (2004) distinguishes between scientific ontology, “the study of what is, or what exists; the

study of entities or things”, and philosophical ontology, “the study of what it is to be or to exist; what all the things that are have in common”. To him it is helpful to “distinguish the study of being (ontology) from the study of knowledge and its presupposition (about being)”. Both are matters of ontology. The latter emphasizes on understanding “practices and belief systems” of a society, a scientific theory, etc. (Lawson, 2004).

Enterprise ontology was developed in the 1990’s in line with knowledge management. Its goal was to build abstract representations of an organization to help information design and modeling, for example so that information systems could be aligned on this ontology (Hoogervorst, 2009). The “enterprise engineering” research field ontological approach of organization’s activities is *descriptive*. Still, ontological descriptions are intrinsically normative, not neutral (Laugier, 2013). Indeed, any research for a formalization relies on choices depending on the goal of the ontology and more deeply relies on normative and subjective assumptions about reality. Revealing these purposes and principles when aiming at building on a common ground appears fundamental.

To approach organizational ontology, we can start with organizational theories. Daft identified four characteristics of organizations: “Organizations are (1) social entities that (2) are goal directed (3) are designed as deliberately structured and coordinated activity systems, and (4) are linked to the external environment” [Daft 2001, p. 12].” (Hoogervorst, 2009). This definition echoes the role of accounting in organizational life which is to enable the achievement of goals through the coordination of activities by informing internal and external environments on the well-foundedness of decision. However, in our introductory case study, it appears that accounting can mismatch (and even impede) organizational goals, especially ecological ones. Any attempt to represent, model or theorize organizations embeds ontological presuppositions about reality which are not always made explicit.

Hence, our research questions are: *what are the underlying assumptions on the organizational ontology in accounting? What ontological understanding of the organization is needed to build an ecological accounting system?* They participate in a wider discussion: *What is the stance of ecological accounting in terms of organizational ontology, and what are the implications with regards to the interoperability with other domain ontologies?*

Following our introductory remarks, our approach is first to study *ontological presuppositions* about organization as a methodological choice. This enables us to consider **underlying assumptions about the organizational ontology** in management and organizational studies (focusing on accounting approaches). Second, far from denying the normative aspect of ontology, **we explore what features an ecological organizational ontology should rely on**. This point is motivated by our grounding in ecological accounting which aims at building accountings that integrate reliability towards natural entities and lead to managing human activities regarding their impacts on natural entities. Finally, this latter normative objective relates to an operational function of ontologies which could help bridging sciences through *formal ontology*. We discuss how formal ontologies developed for information systems could be used in management and organization studies too with the help of ecological accounting. That way, an **organization ontology could benefit from other science’s knowledge and help building new knowledge about socio-ecological systems**. This would help “ecologize” (Latour, 1999) organizations.

This paper is structured as follows: in section 2, we explore what ontologies of organizations are underlying in accounting. For this, we examine the way in which accounting's purpose is related to organization goals and operational processes. In section 3, we examine social environmental and sustainability accounting and reporting (SEA) and consider their organizational ontology assumptions with the concern of integrating ecological issues to organization management. In section 4, building on the CARE accounting model we take our introductory case study so that we can highlight how the organizational ontology is framed with the integration of (new) ecological goals. Finally, in section 5 we discuss implications of such an ontological approach regarding its ability to bridging scientific and practical knowledge and identify further research thus needed.

2) The ontological view of organization in accounting-based approaches

In this section we point out approaches to answer the question: what is accounting about?

Our starting point is that accounting can be described, in formal ontology terms, as an informational artifact, or accounting documents as information content entities (Smith and Ceusters, 2015), which by definition stand *in an "aboutness" relation* to organizations. Yet, accounting representations of organizations are non-neutral, they are performative (Hopwood, 1987). Therefore, they relate to different organizational ontologies, which is the focus of our enquiry. By ontology of an organization, we refer to the broad characteristics by which we try to depict the reality of an organization, including its goal(s).

2.1 What is accounting about?

Many definitions of accounting information systems (AIS) exist, along with differing schools of thought in accounting research. We follow Mattessich (2002) in the conditional-normative (CoNAM) school of thought. CoNAM is a synthesis of positive and interpretive-critical schools of thought and an entirely different paradigm, by proposing a pragmatic ontological and epistemic foundation. Richard et al. (2018) adopt CoNAM to provide the overarching definition of AISs we will rely on for the paper: a "set of subjective information systems that have for object the measure of the means and the results of an entity". The entity here is the organizational entity. The "subjective" attribute describes how the AISs are designed to inform certain actors more than others, and that the favoring of some actors over others is politically grounded. This subjectivity changes the goals, or ends, of the organization that is being described by AISs, implying differing means to achieve them.

AISs provide different models of organizations. When seen as "an instrument of modeling or representation of the firm" (Colasse, 2012), AISs' aim is not to give a full depiction of reality and thus mistaking the "map with the territory" (Korzybski, 1958). Rather it is to provide stakeholders with information about the organization's situation.

2.1.1 There exist different AIS

Accounting standards are conventions (Chiapello, 2009) that define what type of information is to be found in accounting systems according to a specific purpose. For some authors, accounting modelizes the organization at a certain stage of its existence, representing its economic and financial situation (Colasse and Lesage, 2013). The conception of organization underlying in French accounting standard is a legal and patrimonial vision of the organization: its liabilities and

use of resources are modeled by the balance sheets, and the income statement (e.g. profit and loss statement - P&L) reflects change in its assets (*ibid.*). The dynamic between accounts, through the debit-credit mechanism, models the operating cycle of the organization.

What AIS unveils about the activities depends on the accounting concepts mobilized (e.g. liabilities, assets, expenses, income) and the way accounts are structured. This can provide a different “picture of the organization” echoing Hines (1988).

Anglo-Saxon P&L	
Expenses	Revenues
Sales production cost	Sales
French P&L	
Expenses	Revenues
Charges related to global production	Sales + Stored products + Fixed assets

Figure 1: Profit and loss statement structured on different accounting concepts can lead to diverse modeling of the organization (authors, adapted from Richard *et al.*, 2018, p.146)

An Anglo-Saxon P&L will provide the reader with information on expenses related to the products sold during the accounting period. A French P&L will differ in informing on all expenses, including non-sold products (i.e. produced and stored).

Figure 1 illustrates that the concept of expense and the choice of information released in the P&L can lead to different organizational modeling, framed by accounting standards. In other words, the translation of an organization into its accounting representation depends on the kind of accounting at issue, its principles and objectives.

If the method of evaluation (historical cost, discounted value, etc.) is also of great importance, to Mattessich (2013) it is a matter of methodology rather than one of ontology. Therefore, when considering hereafter distinct approaches regarding the definition of “value”, we will emphasize the broader characteristics of the AIS in which they take place.

2.1.2 Fair value vs. historical cost accounting: an illustration of how differing approaches shapes accounting and organizations

There are two main perspectives in accounting with regards to value: cost and value. The main approaches they are associated with are respectively historical cost accounting (HCA) and fair value accounting (FVA). They have strong links respectively to the entity and proprietary theory (Biondi, 2011). Each implies a different theoretical background and differing acceptations of accounting concepts, notions and principles. The first is closer to the interests of managers and continuity of the firm. The second incorporates elements from economics, particularly neoclassical economics and favors investors (Casta, 2003; Casta, 2009).

Historical cost accounting is described by Biondi (2011) as “based on the three classic accounting principles of (i) the firm as an entity and a going concern, (ii) matching, and (iii) invested cost and generated revenue.”

In this sense, the business firm isn't owned by any one party. Its goal is to allocate revenue after the production process has occurred. HCA implies the valuation of assets at the historical cost of their purchase. It pursues the finality of the continuity of the firm (see principle (i)), and distinguishes profits from revenue, as its goal is to pursue this activity while recovering operating costs that are due to the consumption of the capital that has been invested in assets (Richard *et al.*, 2018).

Fair Value Accounting proponents have mostly moved from using the term “accounting”, preferring “financial reporting”. Financial reporting is defined as such by the International Accounting Standards Board (IASB) :

“The objective of general purpose financial reporting is to provide financial information about the reporting entity that is useful to existing and potential investors, lenders and other creditors in making decisions relating to providing resources to the entity.

“The objective of financial statements is to provide financial information about the reporting entity's assets, liabilities, equity, income and expenses that is useful to users of financial statements in assessing the prospects for future net cash inflows to the reporting entity and in assessing management's stewardship of the entity's economic resources”. (IASB, 2018).

The purpose of financial statements here is to provide information directly related to the prospects of future net cash inflow, departing from the traditional view of accounting, which shows that the primary beneficiary of financial statements information is the owner. The entity is merely a steward of assets. Financial statements are thus created only to orient decisions for investors. There is no clear existence of the organization as separate from its “owners”. FVA is closer to a market approach of value: in other words, its goal is to capture the value that assets would have to an interested party at a value that is “fair” with regards to their reciprocal interests and the state of the market.

Chiapello (2005) shows that the IASB conceptual framework reverses the historical hierarchy of accounting standards principles where controllability and liability of accounts prevail. Rather, in IASB normalization information relevance is superior for the main perceived user of accounting information: the investor. This encourages an actionnarial vision of the firm which can be envisioned as an aggregation of activities in which the investor's role (no longer the manager's) is to compose activities and obtain a consolidated profit.

2.2 How do accounting information systems and concepts frame the ontology of organizations?

These variations between AIS makes the organization exist differently.

2.2.1 Accounting's purpose is related to organization ontology

Drawing on Richard *et al.* (2018) who highlight that different conceptions of *capital* give a different understanding of assets and liabilities, we focus on the representation of organization underlying according to accounting's structure and concepts (Fig. 2 & 3).

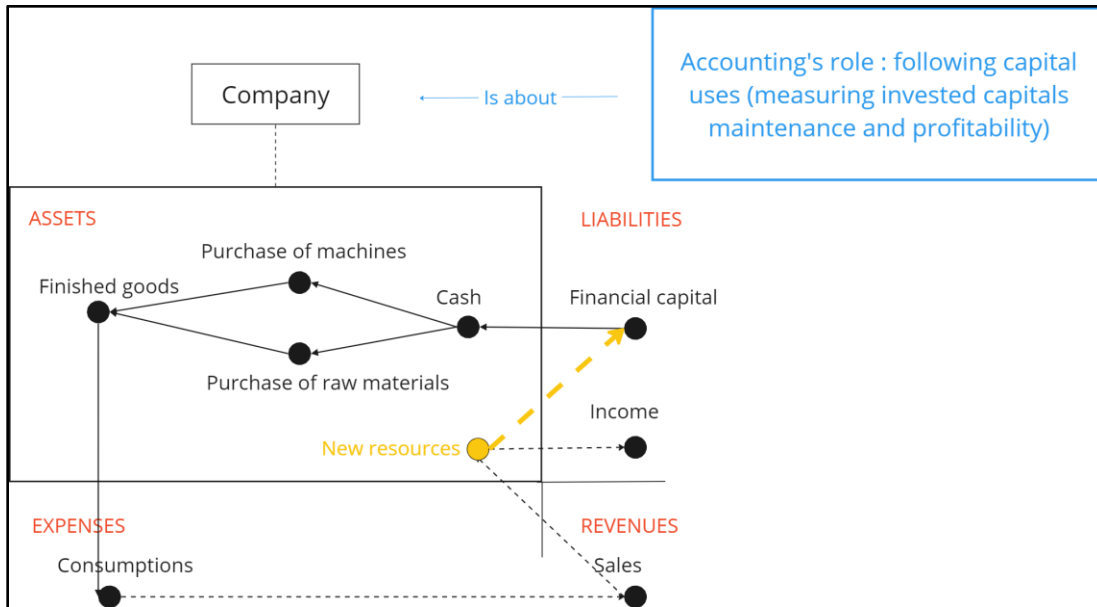


Figure 2: The HCA approach of the organization (authors, adapted from Rambaud and Chenet, 2021).

In HCA, accounting’s structure allows for capital’s uses to be followed. Thus the organization can be observed in line with its uses of capital in time through its assets and expenses. Its goal is to generate revenues so that new resources can reimburse the financial capital which has been consumed for the production process.

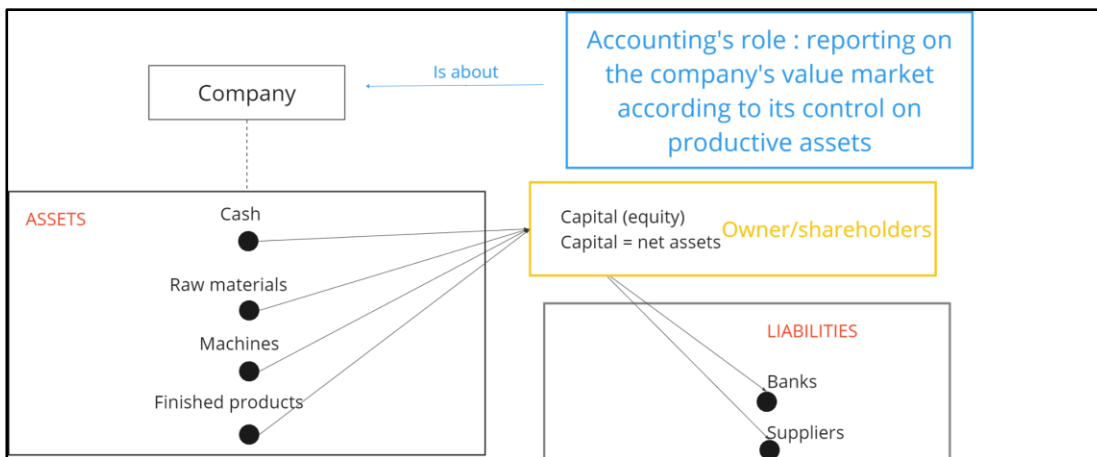


Figure 3: The FVA approach of the organization (authors, adapted from Rambaud and Chenet, 2021).

In FVA, accounting’s structure focuses on the value of the assets controlled by the organization which is thus observed as a list of assets.

Table I summarizes the distinction between the HCA and FVA conceptions of the organization, thus following CoNAM by revealing AISs purposes (Mattessich, 2002).

Table I: The purpose of accounting and the underlying organizational ontology (authors' synthesis of Biondi, 2011 ; Richard et al., 2018 ; Rambaud and Chenet, 2021)

	Historical cost accounting information systems	Fair value accounting information systems
Purpose of accounting (Accounting is about...)	Following capital uses in the production process and its reimbursement Evaluate the solvency and profitability of invested capitals <i>Main users of accounting: owners and managers</i>	Reporting on the company's market value Evaluate the wealth of investors through the value of assets <i>Main users of accounting: shareholders and investors</i>
Organization's goals and ontology	Goals: selling goods or services to generate income for solvency and profitability Ontology: using capital in its production process for selling	Goals: maximize profits and attract shareholders/investors Ontology: list of goods and services (asset with individual value)

Comparing how these AISs model the organization, it appears that FVA is less focused on the well-ordinated vision of the business process, as it favors the fair/future value disconnectedly from the outcome of the production process. Biondi states: “The operating cycle is no longer the focus as it is disaggregated into individual assets that are not meant to be understood as mobilized in a process/in the exploitation cycle” (Biondi, 2011). This can be related to the purpose and role of accounting: in FVA, the most important outcome of the accounting process is material information to its owners rather than the managers who follow the organization's routine activities. The focus is no longer on understanding how capital is being “consumed” through the business and how it re-enters it through sales for its prolongation - rather on the expected price that assets have on a market at a given time (Richard, 2015).

Notorious accounting theorists (see Littleton, 1956; Ijiri, 1971; Richard et al. 2018) have defended HCA. Their arguments include the fact that it offers a better representation of the organizational entity, to the “ongoing productive process of the enterprise entity” (Biondi, 2011), leading to a more prudent management approach. Most organizations today primarily rely on this valuation approach (Christensen and Nikolaev, 2009). However, what is the place of accounting information as far as many information systems compose the life of organizations?

2.2.2 Accounting information system among the diversity of databases and information tools and the underlying ontology of the organization

Practically speaking, organizations mobilize a diversity of information systems that have been developed since the 1970's, including enterprise resource planning (ERP) systems. Since, the special role of accounting information has been challenged by the arrival of information technology in the 1980's (Grenier, 1989).

In this movement, the aim of organizational modeling has notably been to enable database connection for organizational and performance purposes. This raised challenges for the role of

accounting and accountants. Indeed, the integration of the AIS as an information system among others doesn't encourage considering its specificities. As Grenier (1989) points out, if accounting is usually downstream from other information systems, it remains an information system on its own that allows to verify the global coherence of the other subsystems. Nevertheless, information in the AIS are built structures in themselves, that depend on representational choices. He then states that the political accounting choices should be conducted in harmony with the organization's activities and its management principles. If not, it might lead to aberrant behavior from the organization (Grenier, 1989). This points to the necessity for internal coherence, or coherent intra-ontological formal relations (discussed in section 5).

Examining research that addresses the adequation between organizational databases (i.e. systems ontology) and accounting information systems leads us to ask: how accounting concepts are understood, and what is the organizational ontology at stake? We shortly consider an accounting ontology candidate and its extension to formal ontology.

Conceptualized in McCarthy (1982), REA has been developed as a possible accounting ontology (Gailly and Geerts, 2014; Mattessich, 2013) that allowed for the development of practical applications (see REA's development in Nikitkov, 2020). The initial concern was to better fit databases and to answer user's need for information. REA is based on constitutive elements and relationships between them consistent with data modeling techniques. The organizational ontology relies on identifying entities which are economic resources (utility-purpose objects, controlled by the organization) and how these resources are affected by economic events (mainly stow-flow relations) resulting from the action of economic agents and units (persons and hierarchical organization in departments). This general ontology is specified with the available data in an organization. As REA is explicitly based on the FASB framework (McCarthy, 1982), it shares some definitions (e.g. assets and equity) which in turn influence how accounting and organizations are conceptualized, as "accounting conventions [produce] different conceptions of the firm" (Chiapello, 2009).

REA has been integrated in a formal ontology : Core Ontology for Financial Reporting Systems (COFRIS) (Blums and Weigand, 2018; 2020). COFRIS is explored, developed and expanded in (see Blums and Weigand, 2016; 2020; 2023). It is aligned on the IFRS model of accounting, thus on its organizational goals. Focus is put on value creation rather than pursuing production, apparently misaligned with HCA.

2.3 Relevance of an accounting approach of the organization

So far, we have highlighted links between AISs and organizational ontologies. This ontology is framed by accounting concepts, principles and standards which define what is "communicated" and "measured" about an organization. By doing so, accounting also constructs "reality" because decisions and actions are based on this "picture of an organization" (Hines, 1988). This corresponds to performative and retroactive features of accounting: "accounting standards, because they shape the economic image given by companies (their profit levels, debt ratios, equity levels, sales levels, etc.), in turn influence corporate policies. Companies will thus transform their management methods and practices, and the types of contracts they sign, under the impact of accounting changes." (Chiapello, 2005, p. 18-19).

The goals of the organization underlying in accounting frameworks can be broadly summarized between two organization theories: the agency theory characterizes IFRS standards and FVA; while HCA is aligned with the entity theory (Rambaud, Chenet, 2021 ; Biondi, 2011).

Moreover, this exploration underlined differing conceptions of what accounting is which are closely related to what the purpose of accounting is. Two main understandings seen above well echo the words of Ijiri (Ijiri, 1975): “Accounting is a system designed to facilitate the smooth functioning of accountability relationships among interested parties [...] in contrast to the widespread idea that accounting is a system for providing information useful for economic decisions. [...] the latter [...] focuses only upon the relationship between the accountant and the decision maker and does not deal with the important relationship between the decision maker and the entity whose activities are being reported.”. Indeed, in FVA, the decision maker is mainly the shareholder which makes accounting an instrument for reporting on the firm’s market value. Thus, internal management issues are not visible whereas in the first view of Ijiri, accounting plays a key role in *relational* aspects of organization’s life (see the mention of “relationships” in the quote above) and a deeper understanding of the organization’s processes.

With ecological issues and their integration in organizations in mind, it seems all the more relevant to consider that organizations can address these in terms of a genuine (ecological) management. Therefore, building on an accounting framework that embeds a conception of the organization in line with management purposes is preferable.

On the one hand, FVA appears to suffer too many conceptual flaws that make it antagonist to the understanding of the organizational process: “income cannot arise directly from new investments or borrowings, or by action of owners in creating an item in their accounts called “goodwill”, or by owner action in repricing assets already possessed. The reason for this view (...) is that no service has been rendered by this enterprise in connection with these purely financial actions.” (Littleton, 1956 in Biondi, 2011).

On the other hand, HCA appears as a better conceptual framework as its basis is the organizational processes: “The income results from the overall business activity and is represented by the whole of the costs and revenues matched to the period of reference by following the enterprise entity’s process (as represented by the income statement). Accounting requires a comprehensive approach that represents each transaction, operation, combination or event according to the role it plays in the overall entity for time” (Biondi, 2011).

Moreover, Mattessich highlights management for sustainability’s role by evoking the necessity to “extend the traditional accounting for economic wealth to a genuine accountability for the environment (...). This will be the greatest challenge for this millennium”, citing the stake of the “very survival of humankind” (Mattessich, 2002).

The next section is dedicated to analyzing threads of research in environmental accounting and their links to organizational ontology.

3) The ontological view of organization in social and environmental accounting approaches

Social, environmental and sustainability accounting and reporting (SEA) (Gray, 2006) frameworks link ecological issues with organizations. Does the organizational ontology implied in SEA enable organizations to be accountable for social and environmental actions? In this section we first look at the way ecological concerns modify the reality – and thus the ontology – of organizations. We then highlight what organizational ontology is underlying in SEA proposals. We conclude by explaining what kind of ecological AIS may allow for a strong sustainability agenda.

3.1 Ecological issues challenge science and question the responsibility of organizations

Human responsibility in environmental degradations has become unequivocal (IPCC, 2021; IPBES, 2019). We will refer to this as *ecological issues*.

From the 1970's onwards, scholars in management and organization studies have paid attention to landmark works such as the *Brundtland Report* in 1987 which popularized the concept of sustainable development, *The Limits to Growth* (Meadows *et al.*, 1972) and studies about the planetary boundaries conceptualized by Rockström *et al.* (2009). Bebbington and Larrinaga (2014) identified that these reports raised ontological and epistemic questions to management scholars. Indeed, from an ontological point of view, ecological issues intertwine social and natural issues. Thus, ecological issues do not fall into the field of one identified discipline. Rather, systemic analyses of human and natural systems are needed.

Moreover, ecological issues are characterized by complexity (i.e. the difficulty to ontologically describe and study reality), uncertainty (i.e. the impossibility to predict every outcome, following Knight), irreversibilities (i.e. the impossibility for a system to reverse its transformation). This makes traditional scientific approaches not always adapted to understand these issues and constitute “organizational challenges” alike (Ferraro *et al.*, 2015).

However, occidental science has developed on a peculiar ontology of the world. The work of Latour illustrated that the Modern enterprise was to classify “propositions” between the natural and social (Latour, 1999), thus producing a dualist ontology of reality. This idealized and “purified” reality masks the “real reality” which is characterized by “a network of human and non-human entities interacting, associating, allying, and transforming each other” (Rambaud, 2024). Thus, the ontology of the “real world” consists in a relational ontology (Sidorkin, 2002) which emphasizes multiple relations that define the existence of entities. This understanding is more adapted to a proper ecological conception of the world, where ecology refers to: “the interrelations of humans and non-human “entities”, in which we include all living conditions in a broad sense. Therefore “Ecology” encompasses social and natural issues as entangled issues.” (Rambaud, 2022, citing Dajoz, 2006).

To illustrate how sustainability challenges management and organization science, Gladwin *et al.* (1995) summarize through three paradigms – *technocentrism*, *ecocentrism*, *sustaincentrism* – how reality can be grasped. This highlights that building knowledge depends on the framework of thoughts and underpinning conceptions on what the world is. These authors see sustainability concerns as an imperative to modify our understanding of organization.

Finally, ontological issues are raised as far as our relation to the world is enlarged with insights from natural science and human responsibility is at stake. Let's see how attempts to integrate ecological responsibility through SEA proposals deal with organizational ontology.

3.2 What organizational ontologies lies behind SEA proposals?

According to Deegan, SEA can take many forms: "SEA can be thought to relate to the preparation and capture of information to inform stakeholders (within and outside the organisation) about an organisation's impact on the societies and environments in which it operates (including, past, present, and future societies and environments)." (Deegan, 2017, p.66). As a result, SEA shares elements with corporate social responsibility (CSR) or corporate sustainability (CS). CS broadly refers to management tools and concepts which enable aligning with sustainable development principles (Steurer *et al.*, 2005). CSR has a different genealogy as it emerged with ethical consideration about modern corporation's executive leaders regarding their responsibility towards society (Acquier and Aggeri, 2007; Banerjee, 2008).

In particular, SEA, CS and CSR often mobilize stakeholder theories. The notorious definition of Freeman (1984) appears as a renewed conception of the organizational ontology in opposition to Friedman's vision (Marrewijk, 2013). Indeed, the organization must consider a larger scope than the shareholders only and its goals are enlarged to "[satisfying] the objectives of the various stakeholders and coordinate their interests (Evan and Freeman, 1988)." (Chauvey *et al.*, 2015 p. 5). However, the motivation of integrating these "interests" is often a matter of managing stakeholders' relations so that the reputation of the organization is preserved (Steurer *et al.*, 2005) which does not change the focus from solely financial results. In that view, stakeholders are ontologically perceived from an *outside-in* perspective: meaning that they matter to the organization because they affect its operations and not because the organization impacts them - which would correspond to an *inside-out* perspective (Rambaud and Richard, 2016 referring to Schaltegger *et al.*, 1996). Others observe that this approach is limited to connect to management purposes (Orts and Strudler, 2002); properly analyze ecological issues (Acquier and Aggeri, 2007) which often exceed the scale of the organization; or fix conflicts between diverging interests (Chauvey *et al.*, 2015).

These limitations also appear in SEA. We distinguish "*mainstream SEA*" (e.g. Global Reporting Initiative; Triple Bottom Line) from "*accounting for sustainability*"; mainstream SEA seeks to avoid conflicts between organizational interests and ecological issues (Gray, 2010). The goal of the organization is still focused on financial performance and its ontology rely on an *outside-in* perspective (Rambaud, Richard, 2016; Lamberton, 2005). Moreover, these voluntary approaches have a clear tendency to "cherry pick" ecological issues which raises serious questions about the ability of these tools to truly inform on and establish the sustainability of the organization (Gray, 2006). More precisely, it does not refer to any threshold, nor target on environmental or social issues (Rambaud and Richard, 2016) which makes Gray say that claims of sustainability reporting/accounting are "primarily rhetorical" (Gray, 2010, p.50). Finally these approaches are conceptually limited to integrate ecological issues and their complexity: mainstream SEA are pre-determined undisputable analysis for reporting's purpose (GRI) (Chauvey *et al.*, 2015) or result of a choice without systematized methodology (TBL) (Lamberton, 2005).

Consequently, mainstream SEA makes accounting *for* sustainability difficult. This led to the development of other SEA qualified by Gray as “new imaginings” (2002) among which “sustainable cost calculation”, “dialogic accounting”, “accounts for human rights” or “counter accounts” (Deegan, 2017). In these approaches, scholars intend to better reflect (un)sustainability by integrating multiple voices (Gray, 2010). New goals are assigned to the organization: the definition of its performance is enlarged to the examination of new accounts and metrics such as eco-balance or ecological footprint (Gray, 2013). Attempts to account *for* sustainability should be an accounting system centered on sustainability issues, from an *inside-out* perspective: this would avoid solely focusing on organizations, rather on entities that are in relation with these organizations (Gray, 2019). Table II sums up SEA approaches in terms of general purpose and underlying organizational ontology.

Table II: Purpose of “mainstream” and “accounting for sustainability” and underlying organizational ontology (authors’ synthesis)

	Mainstream SEA	Accounting <i>for</i> sustainability
Purpose of accounting	Reporting on the social and environmental performance(s) <i>Main users of accounting: stakeholders whose opinion matters for the reputation of the organization</i>	Unveiling the (un)sustainability of the organization <i>Main users of accounting: outsider of the organization interested in its sustainability</i>
Organizational goals and ontology	Goals: achieving economic and financial performance first, reaching environmental and social performance Ontology: the organization is linked to stakeholders (identified in a standardized list), outside-in perspective	Goals: achieving economic and financial performance without harming natural and human entities Ontology: the organization is impacting natural and social entities, inside-out perspective

The counterproductive effect of a “managerial” approach to sustainability to be found in *mainstream* SEA is also underlined by Ergene *et al.* (2021): concentrating research on corporate sustainability strategies only “slow the velocity at which we are heading towards a system collapse” but do not “[address] the roots of the problem”. According to them, sustainability challenges require an “ontological shift towards a relational view of the world” (Ergene *et al.*, 2021). As a result, a proper accounting framework *for* sustainability requires to make sustainability relevant at the organizational level despite being a system-based concept (Gray, 2013).

3.3 Building accounting on an ecological organizational ontology: integrating ecological finalities and relations.

Some management and organization scholars interested in ecological issues call for a better consideration of other sciences, especially natural and sustainability sciences (Bebbington and Larrinaga, 2014; Ergene *et al.*, 2021; Whiteman *et al.*, 2013). This call suggests a necessity to renew the ontological approach to organizations as a way to help this dialogue.

To some authors, such considerations originate from the special nature of ecological issues and related concepts. Bebbington and Larrinaga (2014) point out that sustainability science's object is about "problem area [...] rather than organization". Gray and Milne underline that "sustainability is both an ecological and societal concept which will only rarely, if at all, coincide with corporate or organizational boundaries" (Gray and Milne, 2004; Milne and Gray, 2007 cited by Gray, 2013). Lamberton similarly identifies: "Rules have been set for achieving sustainability at the macro level (Daly, 1990) but translation of these rules to the micro level is problematic" (Lamberton, 2005). This can be interpreted as a matter of ontology, since it refers to a conceptual challenge to bring sustainability at the scale of organization.

To overcome this difficulty, some recognize the importance of unveiling underlying ontological assumptions in social sciences and working together with other disciplines (Ergene *et al.* 2021) which modifies *what* management science studies and *the way* it is studied (Lukka and Becker, 2022).

Therefore, management and organization scholars face theoretical and methodological challenges. Whiteman *et al.* call for a better integration of theories between management and natural sciences (2013). Their proposal to refer to planetary boundaries is an attempt to connect organizations to ecosystems through the measure of their impacts on ecosystems. Although it allows for a shift in the focus of the environmental debate, this approach still maintains the object-subject distinction. Ecosystems are seen as subjects (moral centers) that pursue their own finalities (Rambaud, 2015). Therefore, the underlying ontology makes it difficult to understand organizations as socio-environmental hybrids: natural entities are not connected to organizational goals.

Reframing the organizational ontology seems to be culturally and conceptually a necessary step if we want to better integrate ecological issues. Ergene and colleagues come to the idea that "novel conceptualizations [are] necessary to create sustainable organization-environment relations" and call for privileging relational ontologies (Ergene *et al.*, 2021 p. 12). This relational conception of the organizational ontology can be understood with the help of Latour and relational approach. To that end, Russel *et al.* (2017) reframe the work program for SEA as a way to "de-modernize", meaning to shift away from the subject-object dichotomy viewpoint to a relational one. "Now it might be argued that [...] the purpose of social and environmental accounting is to help organizations make better and more sensitive choices – that we should judge social, environmental and, ultimately ecological, accounting by managerial criteria, (Schaltegger *et al.*, 2017)." (Gray, 2019 p.8). This reframing is a conceptual and practical shift for organizations.

We attempt at identifying organizational ontologies aligned with relational ontologies in order to properly integrate ecological issues. Organizational finalities are therefore understood as production and capitals' maintenance. If not, ecological accounting enables to challenge the activity (Gray, 2010). Such an AIS would enable to connect managerial goals with (new) ecological ones, through the notion of environmental liability. Next, we detail how CARE is designed for this purpose.

4) Reframing and interrelating the organizational ontology with ecological accounting. An illustrative case study.

In this section, we draw on a case study to show how to apply an accounting *for* sustainability method in an organization. We base our approach on the application of the CARE model to our illustrative case introduced in the introduction. We go deeper in understanding what ecological accounting is about and the related organizational ontology.

4.1 CARE accounting framework and methodology

To understand the approach of accounting and organizations of CARE, we provide insights on its conceptual and methodological framework.

4.1.1 Conceptual framework overview

Conceptual foundations for CARE are that of CoNAM (Mattessich, 2002; Richard *et al.*, 2018), as they allow to study impacts of standards and norms, while accepting as a principle that an accounting information system is intertwined (e.g. Burchell *et al.*, 1980) in its historical and political context.

The framework can be understood through the distinction of the accounting approaches described in section 2 with regards to the definition of value. At the heart of this distinction, Rambaud and Richard (2019) and Rambaud and Chenet (2021) identify the role of the two definitions of capital: an “accounting” one as opposed to an “economist” one. The formal (and historical) definition of capital for accountants is that of a debt, unrelated to interest rates or productivity considerations. The “economist” definition of capital is that of an asset (Richard and Rambaud, 2020). In mainstream economics, capital can be substituted : references to human, natural or environmental capital designate resources to be accumulated, aggregated, maximized, which can be substituted by another as a factor of production (see Solow, 1974). This attitude towards natural and human entities is referred to as “weak” sustainability because of its lack of guarantee to preserve them (Pearce *et al.*, 1989, Clark, 1973) (see Rambaud (2015) for an extensive analysis of the concept of capital and of its extension to natural and human entities).

Thus, CARE was designed as an extension of HCA that enables following the degradation and activating the preservation (reimbursement) of natural and human capitals similarly to financial capital (Rambaud and Richard, 2015). Historical cost is foundational as it allows to apprehend the degradation of ecological entities as tied directly to their material, biophysical impacts and consumption, through their production process, with the timing of the degradations being key to understand the way in which they are degraded as well as to how they may be preserved or not-whereas such information will not be available in market-based approaches.

CARE defines capitals as “entities employed and consumed by the organization through/in its business/organizational model, whose existence is independent from the organization’s activity (and notably its utility/productivity) and recognized as having to be preserved” (Rambaud, 2023).

This framework recognizes that *capitals* are entities that are *matters of concern* which require an ontological investigation, to understand their relations to the operating cycle, or production-reimbursement process of organizations. Thus, according to CARE the organizational ontology

relies on its using and preserving processes of capitals. Therefore, CARE understands two categories of organizational goals: productive ones, associated with capitals consumptions ; and preserving ones, associated with capitals reimbursement.

4.1.2 Methodological framework

CARE also designates the AIS's application method.

In simplified terms, the eight phases of the CARE methodology (**1**) correspond to the structuration of: a first layer of ontologically relevant (e.g. biophysical) information system and description of the organization's activities (P1-4) ; monetary accounts (P5) ; and the organizing and interpreting information to (re)design activities (P6-8).

The types of capitals integrated into organizations are biodiversity, climate, soil, water and humans. The identification of their thresholds and how they are impacted require a proper ontological investigation adapted to the organizations' contexts and processes.

4.2 What is ecological accounting about? Articulation of accounting and organizational process: an illustrative case study

We take a narrative approach to describe the activities and corresponding CARE phases and concepts.

4.2.1 Classifying newly defined informations for (re)designing organizational processes

In our illustrative case study, the groundwater is a (natural) capital providing an input which is processed through the organization and allows for the delivery of a service of contemplation, which is the output.

In the initial situation, the amount of water that is pumped from the ground will be characterized as an asset, (P2) as it is made available by and for the organization. If the removal of the water is considered as deteriorating the good state of the groundwater table (above a given threshold) (P1), this creates a debt, classified in the liabilities side of the balance sheet. Its surface storage is an asset and the consumption of the liquid quantity due to pumping and evaporation will count as a consumption, i.e. charge (P2) on the groundwater table capital.

Post-renovation, the local re-infiltration through the new swale is a restoration activity, equivalent to a reimbursement of the groundwater table capital (P3). Expenses for the digging of the swale are preservation expenses (P5). The filtering garden, which allows for less pumping, is an avoidance activity (P3): an exploitation/production activity that has as a secondary consequence the contraction of a lower ecological debt (P2-3).

For the organization, the question will then be: are these measures enough to restore the good state of the groundwater? And if not, what can be done in terms of "redesigning" (Tsakalidis and Vergidis, 2024) the organizational process (P1-2-3-4-5)?

The answer will depend on several constraints. First, the capabilities of the organization, which will have to arbitrate between lower/higher inputs and/or outputs (reducing pumping and/or evaporation, e.g. by enclosing the basin, which will necessitate more financial inputs). Second, it

will depend on the finalities of the activity: as enclosing the basin might go against the finality of contemplation, it might not be preferable. Finally, it will depend on the required level of reduction of the impact: as very high or low levels of reduction might not call for the same corrective measures.

All of these possibilities will redesign the existing organizational process in a different way, and are interrelated to each other. This necessary information, once classified, treated, and interrelated, will make sense and provide grounds for decision-making. Therefore, the organization can integrate water-related issues as a relevant basis for decision-making, and arbitrations no longer solely rely on financial information. CARE connects organizations to their biophysical realities. This is what ecological accounting does and is about.

Since parts of the organizational process (e.g. water pumping) are absent from financial accounting, ecological accounting necessitates a proper modeling approach adapted to natural capital ontologies, degradation and related temporalities.

4.2.2 How CARE models organizational processes

We can represent the before-after description of the process such as illustrated on Figure 4.

Such an information system creates a common language for local community managers, readable by citizens, written by ecologists, that would constitute a verifiable basis for acquitting or condemning an entity by an administrative judge, an alert mechanism for an endangered ecosystem that guides public financing and fiscality, prioritize water repartition and levels of production for surrounding industries. Moreover, its application doesn't stop at *describing* an activity with ecological impacts since it requires *redesigning* organizational processes.

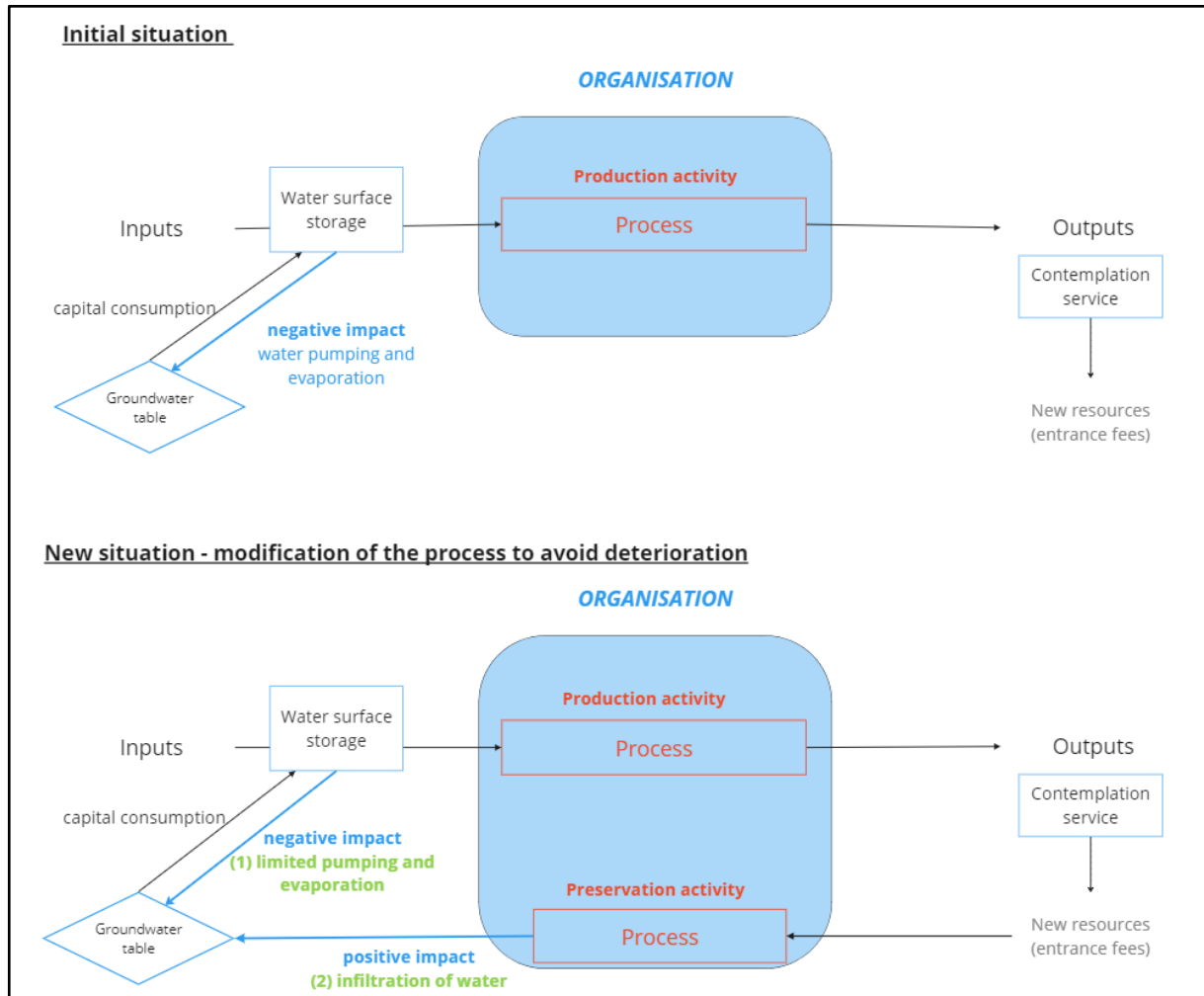


Figure 4: Organizational process mobilizing water, before and after redesign (authors)

Initial situation: The delivery of the contemplation service mobilizes the use of the groundwater table by pumping and evaporation. However, the level of water consumption is not compatible with maintaining the good state of the groundwater.

New situation (renovation plan): The combination of

- (a) avoided negative impacts (filtration basin) - which constitutes a modification of the production process so that it has a less negative impact
- (b) added positive impacts enabling groundwater table's restoration thanks to an infiltration installation

lead to the groundwater table reaching its good ecological state.

Finally, this illustrative case shows that CARE considers natural capitals as part of the organizational ontology. The notion of *impact* is fundamental to qualify these relations and to represent it in accounting. Indeed, this ontology is translated thanks to accounting concepts: liabilities towards natural capitals indicate the *preservation* required because of their mobilization which appears in assets corresponding to the capital *consumption* within the operation processes. Thus, CARE recognizes the traditional accounting goal of an organization which is to produce goods or services, and adds another goal which is to preserve natural entities mobilized in these production processes in their good ecological state.

5) Discussion: bridging domain ontologies with management sciences for ecological planning.

The relevance of an ontological approach as explored in this paper is to be understood at various levels and has implications on other domains, whose existing relation to organizations varies. Thus, further research on ontologies seems necessary to reach coherent and interoperable ontologies for actionable knowledge in organizations.

5.1 Towards a coherent description of organization-related ontologies

In this paper, our mobilization of ontology does not consist in building a proper ontology. Rather it is a way to uncover ontological assumptions, which makes it easier to confront them and establish their (un)consistencies. We showed in section 2 that this task is indispensable with ecological issues, as they modify our understanding of the world, of what *exists*. From this, we can start building organization ontologies that are aligned with natural sciences. This is where a genuine ontological project about *ecologizing* organizations can take place.

5.1.1 Principles of a systemic ontological project

In such a project, the work initiated in this paper is only one element consistent with further deepening about a coherent ontological project as introduced by Lawson regarding social scientific ontology (Lawson, 2004). In our case this type of project, both philosophical and scientific, should be about social *and* natural realities and their relations.

As mentioned in our introduction section, philosophical ontology is about defining what all entities have in common, and scientific ontology defines a specific domain. Lawson (2004) also distinguishes between social and natural science. However, a socio-ecological understanding of *reality* implies to consider both, even at the scale or organization. This is why in our view a social organizational ontology, provided by management and organization science, should be aligned with natural science.

It appears that the principles of ontological projects – as those of Lawson, Smith and Garcia – could lead to a coherent, methodologically structured dialogue between domains that could enrich the understanding of ecological issues:

- The distinction between philosophical and scientific ontologies (Lawson, 2004) enables the development of analytical tools: the philosophical task is both 1) to highlight common features of ontologies underlying sciences; and 2) to determine the conditions of *possibility* of being (e.g. the structure of social entities) which are not exclusively to be found in social and natural science theories. In Lawson's view, this philosophical ontology should remain "conditional and immanent", that is to say "situated, fallible and practically conditioned" thus open to "empirical input" (Lawson, 2004, p.19). This seems to be **adapted to the ontological intricacies and complexity of ecological issues**.
- If properly designed, such an ontological project can be driven by what the French philosopher Garcia (2023) calls a "non-determinist thought". It means that the point is not to determine what should be, nor only to describe what is, but rather to be open to the possibles - thus echoing the second philosophical task of Lawson. This seems to be adapted to the **feature of uncertainty of ecological issues** and the integration of new knowledge.

- This multiple perspective – and thus interdisciplinary (i.e. multi-domain) approach – of organizations and ecological issues could be eased by **the use of formal ontologies**. The Basic Formal Ontology project (see *infra*) could inspire management and organization studies and help the structuration of scientific ontologies (in Lawson’s sense).

5.1.2 Relevance of an ontology building project for organization and management science

Reprising the difference between ontology in philosophy and domain science, Mattessich (2013) underlines the relevance of grounding economics, accounting and information science on philosophical ontologies. Moreover, he notes that traditional (philosophical) ontology could benefit from the development of information science ontology if the latter better seeks to interconnect domain ontologies through “computerizing the process of knowledge creation and dispersion” (Mattessich, 2013). This ultimate goal of ontology could be then pursued.

Thus, our hypothesis is that formalization of ontologies for the CARE R&D program might benefit from both understandings of ontology, and break new grounds of organizational ontology in the philosophical sense, by providing a new understanding of *what are the relations and entities that compose organizations* which can be fostered by ontological development in its information science definition. Indeed, formalizing ontologies can provide notable advantages: clarity, accessibility, evaluability, reusability across other domains and “fostering the ontological interoperability with related domain ontologies; shedding light on the fundamental reasons for the non-interoperability of other domains and theories, situate advances in the domain in R&D and practical instantiations (such as our case study), fostering normative development, by allowing establishment of intra, trans and meta-ontological formal relations” (Grenon and Smith, 2004).

With these objectives in mind, Arp *et al.* (2015) introduced Basic Formal Ontology (BFO). BFO is a project which aims at “supporting information retrieval, analysis and integration in scientific and other domains” (2) through the development of formal ontologies. We introduce hereafter some reasons why BFO appears as a relevant operating frame for our ontology building effort.

Contrary to Mattessich’s (2013) comments on Latour’s epistemic stance, we posit that BFO and Latour share a non-antagonist view of reality, a pluralist-realist one (see Latour, 2003 ; Latour, 1993). This seems especially true with regards to the *a priori* “agnosticism” that BFO and Actor-Network Theory (ANT) (Akrich *et al.*, 2006) share with regards to differentiating subjects from objects. This non-separation also seems coherent with the axiomatizing by David *et al.* (2012) regarding the non-separability of *relations* and *knowledge* as a foundation for management sciences, a step away from both positivism and social-constructivism. It appears compatible with CoNAM (Mattessich, 2002), the accounting paradigm underlying CARE (Richard *et al.*, 2018).

As BFO allows for the representation of scientific knowledge through instantiation as well as studies procedures, i.e. scientific protocols and experiences (e.g. Blank *et al.*, 2016), it appears as a useful, coherent tool for formalizing CARE’s R&D program. Indeed, it could similarly formalize the newfound comprehension of organizations that have procedures in accordance with the newfound goal of preserving natural and human capitals.

5.2 Ecologizing organizations by interoperabilizing ontologies

As far as ecological entities are related to the organization, we have introduced the idea that new domains have to be investigated. From the viewpoint of ontology, it means “interoperabilizing”. Indeed, “interoperability” is described by Tolk and Muguira (2003) as “the ability of two or more systems to communicate effectively both syntactically and semantically” (McDaniel and Storey, 2019).

As we have seen in our case study, and which is more generally inherent to CARE, the integration of ecological entities in accounting paves the way to new relations inside the organization, by mobilizing knowledge from ecological sciences, which must be interpreted and put into action (for instance, through process redesigning) by managers. Thus, CARE relies on a re-configuration of the knowledge-relation to create, in Hopwood’s words, “a manageable organisational domain” (Hopwood, 1987) for ecological entities.

These new relations can lead to ecologize organizations. Latour (1999) defines ecologization as the extension “to every entity the fundamental uncertainty on the exact relation between means and ends”. Ecologizing isn’t about “protecting nature”, rather revoking the systematic *a priori* separation between subjects and objects. This stance is fundamental in ANT (Akrich *et al.*, 2006) to study the modes of existence of “quasi-objects”, and understand them and their inter-relations with other entities without distinguishing human from non-human. This refounds sociology as the following of these quasi-objects through their socio-technico-ecological networks. Key elements of ANT and BFO are similar. Both follow a realist, pragmatist, *flat* ontological approach to reality and allow for the description of humans, non-humans, procedures, instances etc. through interrelated entities. However, if ANT succeeds in describing the complex interrelated entities at work in a specific given occurrence (e.g. the writing of a scientific article), it makes it difficult to systematize and render knowledge accessible (through interoperability) whereas BFO excels in this matter.

Indeed, recomposing (organizational) collectives can be seen here as equivalent to creating ontological interoperability. Thus, BFO appears as a strong contender to pursue the goal of “recomposing” collectives by drawing their connections between organizational processes, ecological entities and processes in a precise and systematic way. First, because of the strong active community that systematically develops ontologies with BFO (Smith *et al.*, 2007). Second, because of the existing work in the formalization of relevant ontologies such as information artifact ontology, Information Systems, AIS, organizations and natural entity ontology which will benefit from interoperability. Third, BFO distinguishes ontological features between *occurents* and *continuants* which notably allows to draw entities, processes and their interrelations. This makes the understanding of organization ontology accessible, precise and systematized.

Following this idea, organizations can be understood as “collectives” that mobilize knowledge, relations, resources and practices through an iterative production cycle that generates output and innovation. Organizations cannot be solely relegated to fixed, mechanistic units (Segrestin and Hatchuel, 2012). David *et al.* (2012) highlight the role of the inseparable knowledge-relations couple in this generating dynamic, in collective action.

With our understanding of organization modified, accounting knowledge must be revised too. Such a challenge echoes accounting’s construction which has been intertwined with tensions between

professional communities. Caron argues that “the scientific project of accounting, which has been developed since the 1970’s with thousands of scientific articles, must answer two necessities: “rebuild relations that are compatible with the modification of knowledge” (...) and “rebuild knowledge that is compatible with a modification of relations (Hatchuel, 2012).” (Caron, 2014).

Relating, or interoperationalizing ontologies is a way to create a common language, a basis of knowledge that enables redesigning collectives (organizations) that can effectively enact a strong sustainability program through newfound relations. Indeed, it allows for the integration of ecological entities into the organizational ontology, effectively creating a bridge to engage in relations characterized by the followance of ecological trajectories and impacts in production. This approach to organizational ontology overcomes the ownership-based separation of private vs. public activities and organizations, which has led to a dearth of research in SEA in the latter (Guthrie *et al.*, 2010), as the focus is now put on ecological impacts.

This bridging first has implications on other ecological entities that are *matters of concern* in CARE. As we have seen in section 4, CARE offers a connection between organizational ontology and ecological entities as they are being used, employed, degraded, by, through and for the organizational process. In some cases, there might be an *overlap* between terms of these entities: in our case study, the groundwater also shares some ontological aspects with the soil. One purpose of ontological formalization will be to ensure the formal coherence of these domain ontologies (here, hydrology and pedology). Without doing so, we can hypothesize that organizations might remain separated from ecological entities or be connected to false or imprecise ontological premises that would hinder a management respectful of their preservation.

We can highlight which ontologies are and will be mobilized in organizational ontology because of CARE's ontological stance and related practical and normative developments. Organizations are embedded in socio-technico-ecological networks, are constituted by and constitute in different ways the law, the economy. BFO appears as a promising tool to unpack the “black boxes” (Latour, 1987) of existing entities that are characterized in specific, separated domain ontologies, their existing and missing interrelations with ecological accounting that can foster or hinder CARE’s development.

5.3 Engaging multiple ontologies through ecological accounting to enact ecological planning

We highlight which ontological domains can be drawn upon and/or impacted by the formalization of CARE in order to provide an anchor for existing and further research, for trans, intra and meta-ontological bridging.

First, AIS ontology. Following the elements mentioned in section 2, more research is needed to understand connections and discrepancies in the field of AIS. Further research is needed to identify connections between AIS ontology, business process modeling (BPM) (Gailly and Geerts, 2014; Partridge, 1995; Partridge, 2002; Almeida and Moreira, 2021, Blums and Weigand, 2016) which have strong tie-ins to the operating process (Tsakalidis and Vergidis, 2020, Richard *et al.*, 2018), including with REA (Trigoa *et al.*, 2016, Vymětal *et al.*, 2008).

Second, ecological entity ontology. CARE's first phases consist in investigating which entities are *capitals* (meaning impacted and having to be preserved) (see section 4). The Ecological

Accounting Chair's R&D program is building information taxonomies regarding these capitals, their good ecological states, the types of impacts caused by processes, and related preservation and avoidance activities. These information classes correspond to capital's ontologies (e.g. with hydrology).

Third, legal ontologies. Accounting and law are closely tied (e.g. Ur-Nammu code). In France, accounting concepts and principles are defined by an intricate relationship between accounting and law (Garnier, 1947). Similarly, the environment, its protection and law share a complex relationship. Bardy (2018) discusses the concept of an "environmental liability" as an instrument to identify environmental risk. It appears to be a way of creating interoperability between accounting law and environmental law ontologies, to prevent discrepancy in mobilized concepts and in legal requirements regarding ecological trajectories as well as regulations and legal definitions surrounding business activity. De Oliveira Rodrigues *et al.* (2019) can be an insightful starting point for ontology building. Bardy (2018)'s work on the concept of environmental liability appears as a fundamental trans-ontological effort between environmental and accounting law. Other efforts from STS might be insightful to reconcile legal ontologies with the practical instances in which they emerge in an intra-ontological way in Latour (2005), or trans-domain (science & law) with Jasanoff (1995).

Fourth: economy ontology (Chiapello, 2008; Rambaud, 2023). The newfound understanding of the organizational process as connected to ecological entities consumption imply that these share a parthood relationship with the economy. Therefore, it seems that knowledge about the economy - epistemology- will be shifted towards ecological economics (Rambaud, 2015) from mainstream economics, particularly environmental economics and externality theory which doesn't delve into the inner workings of organizations. Instead, it refers to the anthropocentric notion of utility. Organizational goal remains the maximization of value. Other references to neoclassical economics (e.g. market efficiency) don't stand up to scrutiny (see Pearce *et al.*, 1989, Clark, 1973). A process-based ontology, in line with AIS and more in line with recommendations from Potts (2010) is better suited to follow day-to-day management practices and instances, better than non-pragmatist hypotheses about organizational behavior such as individual rationality (Favreau, 2006). These management routines are understood through the notion of planning (Thiétart, 2022).

The planning process at stake in organizations and at higher levels is, in economic terms, supported by accounting information systems. We believe that this stance better encapsulates the organizational ontology than standard economics does with market-based approaches. Economic planning necessitates harmonizing organization level accounting information. In France, it was eased by the creation of the General Accounting Plan and the development of nationwide statistics on organizations to orient and prioritize activities (Touchelay, 2011) . Harmonized accounting standards are necessary to make their planning coherent. Analogically, ecological planning should require a similar information harmonization treatment. Therefore, the R&D program outlined in Feger *et al.* (2021) can be framed as ecological planning's (accounting) information system (Durand and Keucheyan, 2024).

Conclusion

In this paper we investigated the following research questions: *What are the underlying assumptions on the organizational ontology in accounting?* And: *What ontological understanding of the organization is needed to build an ecological accounting system?*

We identified two approaches in financial accounting literature, HCA and FVA, which respectively rely on entity and proprietary organizational theories. With FVA, the organization is seen as a list of assets. Its goal is to maximize profits. HCA focuses on following capital's consumptions. The organization is understood as a process-based ontology. Its goal is to maintain production.

When introducing ecological issues, we saw how SEA's initiatives consider organizational ontologies. We identified that *relational ontologies* allow to integrate ecological issues in organizations, thus echoing calls to relate sciences to better integrate ecological issues and concepts.

We illustrated how CARE embeds a processual and relational organizational ontology that integrates natural entities. In this ecological accounting system, the organization integrates new goals - preserving natural capitals.

We discussed how CARE engages with other ontologies to answer our broader research question: *What is the stance of ecological accounting in terms of organizational ontology, and what are the implications with regards to the interoperability with other domain ontologies?*

Our reflection on ontological assumptions on organization paves the way to broader ontological considerations and projects. The application of CARE mobilizes other domain ontologies, and would benefit from a more formal and harmonized framework. This might reconcile existing divergences and contradictions between domains and foster the development of an effective ecological planning (accounting) information system.

Further research includes formalizing HCA, CARE and its instances in organizations, exploring links between existing formal ontologies and the discrepancies in BFO, with the axioms of the research threads we have mobilized in the context of management research paved by David *et al.* (2012).

Finally, our work on ontologies opens to epistemological reflections on accounting and echoes Caron's (2014) call for a cross-domain knowledge-relation coherence in organizations, to formally address ecological planning.

Notes

- (1) See <https://www.cerces.org/methodologie-care> for CARE's methodological details.
- (2) Source : <https://basic-formal-ontology.org/>

References

- Acquier, A., Aggeri, F. (2007). "Une généalogie de la pensée managériale sur la RSE". *Revue française de gestion*, 180(11), pp.131-157. doi: 10.3166/rfg.180.131-157

- Akrich, M., Callon, M., & Latour, B. (2006). *Sociologie de la traduction: textes fondateurs*. Presses des MINES.
- Almeida, M., Moreira, C. (2021). “Toward an ontological representation for corporate financial documents and their components: an investigation on balance sheets and their accounts”. Workshop on the Ontology of Social, Legal and Economic Entities. Italy.
- Amblard, M. (2004). “Conventions et comptabilité: vers une approche sociologique du modèle”. *Comptabilité-Contrôle-Audit*, numéro spécial, juin, pp.47-68.
- Arp, R., Smith, B., Spear, A.D. (2015). “Building Ontologies with Basic Formal Ontology”. MITPress. doi: 10.7551/mitpress/9780262527811.001.0001
- Banerjee, S. B. (2008). “Corporate Social Responsibility : The Good, the Bad and the Ugly”. *Critical Sociology*, 34(1), pp.51-79. doi: 10.1177/0896920507084623
- Bardy, J. (2018). *Le concept comptable de passif environnemental, miroir du risque environnemental de l'entreprise*. PhD Thesis. Université Côte d’Azur.
- Bebbington, J., Larrinaga, C. (2014). “Accounting and sustainable development : An exploration”. *Accounting, Organizations and Society*, 39(6), pp.395-413. doi: 10.1016/j.aos.2014.01.003
- Biondi, Y. (2011). “The Pure Logic of Accounting: A Critique of the Fair Value Revolution”. *Accounting, Economics, and Law*: Vol. 1: Iss. 1, Article 7. doi: 10.2202/2152-2820.1018
- Blank, C.E., Cui, H., Moore, L.R. et al. (2016). “MicrO: an ontology of phenotypic and metabolic characters, assays, and culture media found in prokaryotic taxonomic descriptions”. *Journal of Biomedical Semantics* 7, 18.
- Blums, I., Weigand, H. (2016). “Using an Ontology Pattern Stack to engineer a Core Ontology of Accounting Information Systems”. *Proceedings of the Joint Ontology Workshops at the 9th International Conference on Formal Ontology in Information Systems (FOIS 2016)*. Annecy, France.
- Blums, I., Weigand, H. (2018). “Towards a Core Ontology for Financial Reporting Information Systems (COFRIS). On the Move to Meaningful Internet Systems.” *OTM 2017*, pp.302-306
- Blums, I., Weigand, H. (2020). “Towards a Core Ontology of Economic Exchanges for Multilateral Accounting Information Systems”. *2020 IEEE 24th International Enterprise Distributed Object Computing Conference (EDOC)*, Eindhoven, Netherlands, pp.227-232, doi: 10.1109/EDOC49727.2020.00035.
- Blums, I., Weigand, H. (2023). “Ontological grounding of accounting frameworks”. *42nd International Conference of Conceptual Modeling*. doi:10.1007/978-3-319-73805-5
- Burchell, S., Clubb, C., Hopwood, A., Hughes, J., and Nahapiet, J. (1980). “The roles of accounting in organizations and society”. *Accounting, organizations and society*, 5(1), pp.5-27.

- Caron, M.A. (2014). *Revisiter la comptabilité pour refonder l'action collective*. Essais. Sciences Humaines (Ed.). doi: 10.3917/sh.segre.2014.01.0108
- Casta, J.F. (2003). "La comptabilité en "juste valeur" permet-elle une meilleure représentation de l'entreprise?". *Revue d'économie financière*, 2 (71), pp.17-31. Halshs-00170460
- Casta, J.F. (2009). "Théorie positive de la comptabilité." In Colasse, B. (2009). *Encyclopédie de comptabilité, contrôle de gestion et audit*, Economica, Paris, pp.1393-1402, 2009. Halshs-00679544
- Chauvey, J.N., Naro, G., Seignour, A. (2015). "Rhetoric and the myth of Global Performance. An analysis of the Global Reporting Initiative's discourse." *Critical Perspectives on Accounting*, 33, pp.79-91. doi: 10.1016/j.cpa.2014.09.013
- Chiapello, E. (2005). "Transformation des conventions comptables, transformation de la représentation de l'entreprise." In *Les normes comptables internationales, instruments du capitalisme financier*, pp.121-150. Michel Capron (eds). La découverte.
- Chiapello, E. (2009). "The Accounting Construction of the Economy." in: *Dizkurs und Ökonomie. Diskursanalytische Perspektiven auf Märkte und Organisationen*, Diaz-Bone Rainer, Krell Gertraude (eds)., Wiesbaden: Verlag für Sozialwissenschaften (VS-Verlag), pp.125-149
- Christensen, H. B., Nikolaev, V. (2009). "Who uses fair value accounting for non-financial assets after IFRS adoption." Unpublished SSRN working paper.
- Clark, C. (1973). "The Economics of Overexploitation: Severe depletion of renewable resources may result from high discount rates used by private exploiters". *Science*. 17 Aug 1973. Vol 181, Issue 4100. pp.630-634. doi: 10.1126/science.181.4100.630
- Colasse, B. (2012). *Les fondements de la comptabilité*. La Découverte. 128p.
- Colasse, B. and Lesage, C. (2013) *Introduction à la comptabilité*. 12e édition. Paris: Economica.
- David, A., Hatchuel, A. and Laufer, R. (2012) *Les nouvelles fondations des sciences de gestion : éléments d'épistémologie de la recherche en management*. Presses des Mines, p. 278.
- De Oliveira Rodrigues, C.M., De Freitas, F.L.G., Barreiros, E.F.S., De Almeida Filho, A.T. (2019). "Legal ontologies over time: A systematic mapping study". *Expert Systems with Applications*. Volume 130, 15 September 2019, pp.12-30.
- Deegan, C. (2017). "Twenty five years of social and environmental accounting research within Critical Perspectives of Accounting : Hits, misses and ways forward". *Critical Perspectives on Accounting*, 43, 65-87. doi: 10.1016/j.cpa.2016.06.005
- Durand, C., Keucheyan, R. (2024). *Comment bifurquer: Les principes de la planification écologique*. La Découverte.

- Ergene, S., Banerjee, S. B., Hoffman, A. J. (2021). “(Un)Sustainability and Organization Studies : Towards a Radical Engagement”. *Organization Studies*, 42(8), 1319-1335. doi: 10.1177/0170840620937892
- Favreau, O. (2006). “Objets de gestion et objet de la théorie économique”. *Revue française de gestion*. January 2006. doi: 10.3166/rfg.160.67-80
- Feger, C., Levrel, H., Rambaud, A. (2021). “Ecological Accounting: How to organize information for biodiversity conservation decision and action at the national, business and ecosystem levels?”. Working Paper, Ecological Accounting Chair and AgroParisTech, Paris, France
- Ferraro, F., Etzion, D., Gehman, J. (2015). “Tackling grand challenges pragmatically: Robust action revisited”. *Organisation Studies*, Vol.36, pp. 363–390.
- Freeman, E., (1984), *Stakeholder management, a strategic approach*.
- Gailly, F., Geerts, G. (2014). “Business process modeling: An accounting information systems perspective”. *International Journal of Accounting Information Systems* 15 (2014) 185–192.
- Garcia, T. (2023). *Laisser être et rendre puissant*. Puf.
- Garnier P. (1947). *La comptabilité, algèbre du droit et méthode d'observation des phénomènes économiques*. Dunod.
- Gladwin, T. N., Kennelly, J. J., Krause, T.-S. (1995). “Shifting Paradigms for Sustainable Development: Implications for Management Theory and Research”. *The Academy of Management Review*, 20(4), 874-907. doi: 10.2307/258959
- Gray, R. (2002). “The social accounting project and Accounting Organizations and Society Privileging engagement, imaginings, new accountings and pragmatism over critique?” *Accounting, Organizations and Society*, 27(7), 687-708. doi: 10.1016/S0361-3682(00)00003-9
- Gray, R. (2006). “Social, environmental and sustainability reporting and organisational value creation? Whose value? Whose creation?”. *Accounting, Auditing & Accountability Journal*, 19(6), 793-819. doi: 10.1108/09513570610709872
- Gray, R. (2010). “Is accounting for sustainability actually accounting for sustainability...and how would we know? An exploration of narratives of organisations and the planet.” *Accounting, Organizations and Society*, 35(1), 47-62. doi: 10.1016/j.aos.2009.04.006
- Gray, R. (2013). “Back to basics: what do we mean by environmental (and social) accounting and what is it for?—a reaction to Thornton.” *Critical Perspectives on Accounting*, 24, 459–468.
- Gray, R. (2019). “Towards an Ecological Accounting: Tensions and Possibilities”. *Social and Environmental Accounting* (p. 53-69). doi: 10.1142/9789813225589_0005

- Grenier, C. (1989). “Des systèmes comptables aux systèmes d’information: révolution ou retour aux sources?” *10ème Congrès de l’AFC, France*.
- Grenon, P. and Smith, B. (2004) “SNAP and SPAN: Towards Dynamic Spatial Ontology”, *Spatial Cognition & Computation*, 4(1), pp. 69–104. doi: 10.1207/s15427633scc0401_5.
- Guthrie, J., Ball, A., Farneti, F., (2010). “Advancing Sustainable Management of Public and Not For Profit Organizations”. *Public Management Review*. July 2010. doi: 10.1080/14719037.2010.496254
- Hines, R. D. (1988). “Financial accounting : In communicating reality, we construct reality.” *Accounting, Organizations and Society*, 13(3), 251-261. doi: 10.1016/0361-3682(88)90003-7
- Hoogervorst, J. A. P. (2009). *Enterprise Governance and Enterprise Engineering*. Springer Berlin Heidelberg. doi: 10.1007/978-3-540-92671-9
- Hopwood, A. (1987) ‘The archeology of accounting systems’, *Accounting, Organizations and Society*, 12(3), pp. 207–234. doi: 10.1016/0361-3682(87)90038-9.
- IASB. (2018). *Conceptual Framework for Financial Reporting*.
- IPBES. (2019). “*Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.*” E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 p. doi: 10.5281/zenodo.3831673
- IPCC - Eyring *et al.* (2021). “*Human Influence on the Climate System. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*”, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 423–552. doi: 10.1017/9781009157896.005
- Ijiri, Y. (1971). “A Defense for Historical Cost Accounting.” In R.R. Sterling (ed.), *Asset Valuation and Income Determination*, Scholars Book, pp.1-14.
- Ijiri, Y. (1975). “Theory of Accounting Measurement”. *Studies in Accounting Research*, 10.
- Jasanoff, S. (1995), *Science at the Bar: Law, Science, and Technology in America*. Harvard University Press.
- Korzybski, A. (1958). *Science and sanity: An introduction to non-Aristotelian systems and general semantics*. Institute of GS.
- Lamberton, G. (2005). “Sustainability accounting—A brief history and conceptual framework”. *Accounting Forum*, 29(1), 7-26. doi: 10.1016/j.accfor.2004.11.001

- Latour, B. (1987). *Science in Action: How to Follow Scientists and Engineers through Society*, Harvard University Press, 1987.
- Latour, B. (1993). *We have never been modern*. Harvard University Press. ISBN 978-0-674-94839-6.
- Latour, B. (1999). *Politiques de la nature. Comment faire entrer les sciences en démocratie*, Paris, La Découverte, « Armillaire ».
- Latour, B. (2003). "The promises of constructivism". in *Don Ihde: Chasing Technology: Matrix of Materiality, Indiana Series for the Philosophy of Science*, Indiana University Press, pp. 27-46 (2003).
- Laugier, S. (2013). *Why We Need Ordinary Language Philosophy*. University of Chicago Press.
- Lawson, T. (2004). "A conception of ontology". *mimeograph, University of Cambridge*, 60.
- Littleton, A.C. (1956). "Economists and Accountants". *The Illinois Certified Public Accountant*, 18-24. Chicago (IL): Illinois CPA Society (ICPAS).
- Lukka, K., Becker, A. (2022). "The future of critical interdisciplinary accounting research : Performative ontology and critical interventionist research". *Critical Perspectives on Accounting*, 102447. doi: 10.1016/j.cpa.2022.102447
- Mattessich, R. (2002). "Accounting Schism or Synthesis? A Challenge for the Conditional-Normative Approach", *Canadian Accounting Perspectives*.
- Mattessich, R. (2013). *Reality and Accounting: Ontological Explorations in the Economic and Social Sciences*. 1st Edition. Routledge. doi: <https://doi.org/10.4324/9780203798737>
- McCarthy, W. (1982) 'The REA Accounting Model: A Generalized Framework for Accounting Systems Shared Data Environment', *The Accounting Review*, LVII, No. 3.
- McDaniel, M., Storey, V. (2019). "Evaluating Domain Ontologies: Clarification, Classification, and Challenges". *ACM Computing Survey*. 52, 4, Article 70 (September 2019), 44p. doi: 10.1145/3329124
- Meadows, D. et al., (1972). *The Limits to Growth - Club of Rome*, Club of Rome. Switzerland.
- Nikitkov, A. (2020). "REA model, its development and integration as an enterprise ontology framework". *Accounting and Management Information Systems* Vol. 19, No. 3, pp. 566-594, 2020.
- Orts, E. W., Strudler, A. (2002). "The Ethical and Environmental Limits of Stakeholder Theory". *Business Ethics Quarterly*, 12(2), 215-233.
- Partridge, C. (1995). *Business Objects: Re-Engineering for Re-Use*. 2nd Ed. The BORO Centre.

- Partridge, C. (2002). *A new foundation for accounting: Steps towards the development of a reference ontology for accounting*. Technical Report 23/02, LADSEB-CNR. Padova, Italy, December 2002
- Pearce, D.W., Markandya, A., Barbier, E. (1989). *Blueprint for a Green Economy*. Earthscan, 192 p.
- Potts, J. (2010). “Ontology in Economics”. in Poli, R., Seibt, J. (2010). *Theory and Applications of Ontology: Philosophical Perspectives*. Springer. pp.277–285.
- Rambaud, A. (2015). *La valeur de l’existence en comptabilité : Pourquoi et comment l’entreprise peut (p)rendre en compte des entités environnementales pour « elles-mêmes »*. Université Paris Dauphine-Paris IX.
- Rambaud, A. (2022). “CARE : Repenser la comptabilité sur des bases écologiques”. *L’Économie politique*, 93(1), pp.34-49.
- Rambaud, A. (2023). “Comptabilité & Théorie de valeur. Pour une autre vision de l’écologisation de l’économie”. *Regards croisés sur l’économie* 2023/1 (n° 32) 32), pages 70 à 79. Éditions La Découverte. ISSN 1956-7413. doi: 10.3917/rce.032.0070
- Rambaud, A. (2024). “How Can Accounting Reformulate the Debate on Natural Capital and Help Implement Its Ecological Approach?” *International Journal of Political Economy*, 53(1), 67-95. doi: 10.1080/08911916.2024.2321428
- Rambaud, A., Chenet, H. (2021). “How to re-conceptualise and re-integrate climate-related finance into society through ecological accounting?” *Bankers, Markets and Investors*, 166, 20–43
- Rambaud, A., Richard, J. (2015). “The “Triple Depreciation Line” instead of the “Triple Bottom Line”: Towards a genuine integrated reporting”. *Critical Perspectives On Accounting*, 2015, Special Issue on Social and Environmental Accounting, 33, pp.92-116.
- Rambaud, A., Richard, J. (2016). *Recognising environmental issues in performance measurement*.
- Rambaud, A., Richard, J. (2019). *Le capital : analyse croisée comptable, économique et historique*. Autorité des normes comptables.
- Richard, J. (2015). “The dangerous dynamics of modern capitalism: From static to IFRS’ futuristic accounting”, *Critical Perspectives on Accounting*, 30, p. 9-34. doi: 10.1016/j.cpa.2014.09.003
- Richard, J., Bensadon, D., Rambaud, A. (2018). *Comptabilité financière*. 11e édition. Dunod.
- Richard, J., Rambaud, A. (2020). *Révolution comptable: pour une entreprise écologique et sociale*. Editions de l’Atelier.

- Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S. III, Lambin, E. F., *et al.* (2009). “A safe operating space for humanity”. *Nature*, 461, 472–5.
- Russell, S., Milne, M.J., Dey, C. (2017). “Accounts of Nature and the Nature of Accounts: Critical reflections on environmental accounting and propositions for ecologically informed accounting”. *Accounting, Auditing & Accountability Journal*. doi: 10.1108/AAAJ-07-2017-3010.
- Segrestin, B., Hatchuel, A. (2012). *Refonder l'entreprise*. Ed. Seuil. ISBN : 978-2-02-106428-5
- Sidorkin. (2002). “Ontology, Anthropology, and Epistemology of Relation”. *Learning Relations: Impure Education, Deschooled Schools, & Dialogue with Evil, Vol 173.*, 91-102.
- Smith, B. (2004). *Ontology and Information Systems*.
- Smith, B., Ashburner, M., Rosse, C. *et al.* (2007). “The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration”. *Nature Biotechnology* 25, 1251–1255.
- Smith, B., Ceusters, W. (2015). “Aboutness: Towards Foundations for the Information Artifact Ontology”. Conference paper, *ICBO*.
- Solow, R.M. (1974). “Intergenerational Equity and Exhaustible Resources”. *The Review of Economic Studies*, Vol. 41, Symposium on the Economics of Exhaustible Resources, pp. 29-45 Oxford University Press
- Steurer, R., Langer, M. E., Konrad, A., Martinuzzi, A. (2005). “Corporations, Stakeholders and Sustainable Development I: A Theoretical Exploration of Business–Society Relations”. *Journal of Business Ethics*, 61(3), pp.263-281. doi: 10.1007/s10551-005-7054-0
- Thiétart, R. (2022). “La planification.” In Thiétart, R. (2022). *Le management*. pp.22-43. Presses Universitaires de France.
- Tolk, A., Muguira, J. (2003). “The Levels of Conceptual Interoperability Model”. *Fall Simulation Interoperability Workshop. Orlando, Florida, September 2003*
- Touchelay, B. (2011). “L’État et l’entreprise: Une histoire de la normalisation comptable et fiscale à la française.” Rennes, France: Presses Universitaires de Rennes, 2011.
- Trigoa, A., Belfo, F., Estébanez, R.P. (2016) “Accounting Information Systems: evolving towards a business process oriented accounting”. *Procedia Computer Science* 100 (2016) p. 987–994.
- Tsakalidis, G., Vergidis, K. (2020). “Business process management: from a critical review to a contemporary ontological entity”. *Int. J. Business Process Integration and Management*, Vol. 10, No. 2, pp.148–161

- Tsakalidis, G., Vergidis, K (2024) “Business Process Redesign: A Systematic Review of Evaluation Approaches Prior to Implementation” *Decision Making: Applications in Management and Engineering*. Volume 7, Issue 1 (2024) pp.79-98
- Van Marrewijk, M. (2013). “Concepts and Definitions of CSR and Corporate Sustainability : Between Agency and Communion”. In A. C. Michalos and D. C. Poff (Éds.), *Citation Classics from the Journal of Business Ethics* pp.641-655. Springer Netherlands. doi: 10.1007/978-94-007-4126-3_32
- Vymětal, D., Hučka, M., Huňka, F., Kašík, J. (2008). “Production planning model using REA ontology”. *Ekonomika a management*. 4 / 2008. 93.
- Weigand, H. (2020). “What is in an accounting ontology?” Discussion Paper.
- Whiteman, G., Walker, B., Perego, P. (2013). “Planetary Boundaries : Ecological Foundations for Corporate Sustainability”. *Journal of Management Studies*, 50(2), pp.307-336. doi: 10.1111/j.1467-6486.2012.01073.x