Ontology and Ontologies in Information Systems Analysis and Design: A Critique

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ABSTRACT

Ontology and the concept of ontologies have attracted considerable attention in the context of research on information systems analysis and design. Being rooted in philosophy, both ontology and the concept of ontologies bear their own history of philosophical debates which have quite often been ignored when applied in the field of information systems. In this contribution it is claimed that a more comprehensive discussion of well-known philosophical issues of ontology and ontologies will help us not only to understand the scope of their applicability in the context of information systems analysis and design. It will also provide us with insights about limitations as well as with directions for issues in need of further research. The argument is critical yet affirmative. It aims at the expansion of the scope of current discourses and focuses especially on socio-philosophical aspects that need to be addressed in order to leverage the full potential of using ontology and ontologies for the provision of a theoretical foundation for information systems analysis and design..

Keywords

Information systems analysis and design, formal ontologies, philosophical ontology, modeling grammars.

INTRODUCTION

In the last two decades *ontology* and *ontologies* have gained considerable attention in the field of information systems research and practice, especially in the domain of information systems analysis and design (ISAD) (e.g., Checkland, 1981; Boland, 1982; Winograd & Flores, 1986; Wand & Weber, 1988; Floyd, 1992; Hirschheim et al., 1995; Weber, 1997a; Green & Rosemann, 1999; Milton et al., 2000; Fettke & Loos, 2003).

Understanding information systems as essentially representational systems, i.e., systems that represent facts about the 'outside world', it is of major interest to know what there is to be represented and how to represent it. Thus, it is only of consequence when information systems research turns its attention to the philosophical discipline *ontology* that has ever since been concerned with "being" and "what exists."

Of all domains within information systems research and practice it is most likely the domain of ISAD that has the most and the strongest ties to the world "out there." It is, in general, concerned with the analysis of "real-world" systems, the determination of changes that should occur in the "real-world" after the introduction (or modification) of an information system (elicitation of requirements), and eventually, based upon these requirements, the design of information systems.

ISAD is embedded in the whole systems development life cycle. As such it is generally understood as part of a methodical process that covers all activities from the identification of problems and opportunities to the implementation and evaluation of the system (Kendall & Kendall, 1992, p. 66 ff.). An essential feature of ISAD is its use of models that on the one hand capture parts of the 'real world' to be represented in the information systems, and, on the other hand, capture certain characteristics of the information system to be developed, e.g., its design. The acknowledged importance of modeling for ISAD finds its expression in the abundance of modeling methods available and in the continuous efforts to improve these methods as well as to develop new ones. Yet despite the abundance of modeling methods, they hardly come with any theoretical foundation. And it is here where the interest of ISAD in ontology and ontologies arises (e.g., Wand & Weber, 1988; Wand et al., 1995; Wand, 1996).

The attraction of ontology is certainly due to its status as a well-established philosophical discipline, equipped with tradition, famous individuals, a host of literature, and a high reputation in the general scientific community. As such we should welcome the possibility of information systems research opening up and drawing on the findings of other well-established disciplines. But, as always, there are certain limitations we need to be aware of. Information systems researchers are seldom philosophers. Our drawing on a discipline we are not familiar with is prone to the fallacies of gross misunderstandings, false

analogies, and the like. Especially in philosophy, almost every term comes with its own history of debates; precise definitions are rare and in order to fully grasp a notion we first need to know and to understand the theory behind it. Nevertheless, there are good reasons why we should become engaged in philosophical theory. As COLLIER (1994) states, a "good part of the answer to the question 'why philosophy?' is that the alternative to philosophy is not no philosophy, but bad philosophy. The 'unphilosophical' person has an unconscious philosophy, which they apply in their practice – whether of science or politics or daily life" (p. 17). Since the meaning of *ontology* and *ontologies* is bound to the respective philosophical theories that are being used as horizons of interpretation, we should not only be aware of their immediate consequences for the understanding of *ontology* and *ontologies* but should also be aware of more distant consequences that derive from the use of the respective theory.

A quite common understanding of *ontology* and *ontologies* in the ISAD literature is based on the ontological theory of BUNGE (1977; 1979; 1993). As such it is grounded in a rather materialist-realist philosophical position that hardly finds any support in contemporary philosophy and social sciences. Consequently, when we consistently follow the ideas of BUNGE, it is impossible to connect the ontological foundation of ISAD with most of the contemporary literature dealing with the social world that ultimately provides us with everything that might be represented in an information system. Hence, the uncritical adoption of BUNGE's ontological theory not only restricts our understanding of the world but also narrows our view to such an extent that we become unable to recognize the limitations as well as the negative ethical consequences of the application of this theory.

It is not my intention to dogmatically counter BUNGE's theory with another theory. Rather I ask the curious reader to engage in critical reflection when s/he is about adopt *any* ontological theory as a foundation for ISAD. In HABERMAS' (1972) sense, the ontological foundation of information systems analysis and design should not solely be guided by an instrumental-technical and/or a practical-hermeneutical cognitive interest but also by an emancipatory interest that eventually helps to overcome self-inflicted cognitive constraints.

ON ONTOLOGY, ONTOLOGIES AND INFORMATION SYSTEMS ANALYSIS AND DESIGN

It seems warranted to say that during the last two decades the concepts *ontology* and *ontologies* have gained considerable attention in the field of information systems research and development. Actually, this is a false statement since it conveys the impression that the words *ontology* and *ontologies* each refer to a single well-formed concept. Already a superficial reading of relevant literature reveals that there are many (different) concepts whose commonality sometimes only exists in sharing the name "ontology." Thus, in order to be more precise, one should write: the words "ontology" and "ontologies" enjoy an increasingly widespread use in the information systems literature.

When confronted with a plurality of meanings of the word "ontology" one might be tempted to ask: "if ontology is everything, maybe it is nothing?" Refraining from the apparent nihilism in this question a profound skepticism is appropriate if one is about to base such serious tasks as information systems analysis and design on 'the' concept of ontology. The fact that the spell-checker of the Microsoft word-processor rejects the plural of the word "ontology*"* seems to be a rather far-fetched motivation for the closer examination of the words *ontology* and *ontologies*, but it points directly to a fundamental issue.

Even if early Greek philosophers were already concerned with ontological problems, it was only in the 17th century that the word *ontology* was introduced to denote a branch of philosophy (contemplative sciences) (Goclenius, 1613, p. 16). Refraining from confronting the reader with the etymology of the word *ontology,* this contribution focuses on the exploration of a distinction which is considered to be most useful for the understanding of what ontology is *all* about. The following encyclopedic definition will serve as starting point for this purpose: "The word 'ontology' is used to refer to philosophical investigation of existence, or being. Such investigation may be directed towards the concept of being, asking what 'being' means, or what it is for something to exist; it may also (or instead) be concerned with the question 'what exists?', or 'what general sorts of things are there?'" (Craig, 1998).

This definition is flawed in one major respect: it might lead the reader to the conclusion that both questions – "what does it mean for something to exist?" and "what exists?" – can be answered independently. But it is trivial to realize that we cannot answer the question "what exists?" without having answered the question "what does it mean for something to exist?" first. With HEIDEGGER's words: "Basically, all ontology, no matter how rich and firmly compacted a system of categories it has at its disposal, remains blind and perverted from its own aim, if it has not first adequately clarified the meaning of Being, and conceived this clarification as its fundamental task" (Heidegger, 1962, p. 31). Another important point was made by KANT who criticized the very idea of ontology. According to him, ontology "presumptuously claims to supply, in systematic doctrinal form, synthetic *a priori* knowledge of things in general" (Kant, 1787, B303). In his argument he opposes realism to idealism: *realism* means that we perceive objects whose existence and nature are independent of our perceptions, whereas

idealism means that they are dependent on our perception. Not satisfied with both positions, he argues: "Thoughts without content are empty, intuitions without concepts are blind. It is, therefore, just as necessary to make our concepts sensible, that is, to add the object to them in intuition, as to make our intuitions intelligible, that is, to bring them under concepts. These two powers or capacities cannot exchange their functions" (Kant, 1787, B75). KANT reversed the classical view of epistemology, known as "Copernican turn" in philosophy. Instead of understanding knowledge as conforming to objects, we have to understand the objects as conforming to the conditions of the possibility of our knowing. Thus, human knowledge is limited to appearances; we are not able to know of the "things-in-themselves" – ontology cannot tell us anything about "things-in-themselves." KANT brought to our attention that all ontology is epistemic bound. Hence, ontology without epistemology is without any merit. This idea has been fully developed by HEIDEGGER. In response to KANT (1787), to whom the "scandal of philosophy" was that no proof has yet been given of the "existence of things outside of us" (Bxl), HEIDEGGER (1962) argues that the scandal is "not that this proof has yet to be given, but that such proofs are expected and attempted again and again" (p. 249). Following HEIDEGGER, the question for the nature of reality of the external world poses a pseudo-problem.

In the classical understanding dating back to the early Greek philosophers, *ontology* was understood as a science, or as a discipline within or next to metaphysics. As such, there was no plural of the word *ontology*. We do not speak about "biologies" just because different scientists have a different understanding of biology. It is not known when and who it was who first used the word ontology in its plural form, but the idea of multiple ontologies has always been connected with philosophical issues of language. In his studies on language WILHELM VON HUMBOLDT (1963) came to the conclusion that people of different languages construct their world differently. NIETZSCHE (1873), most radically for his time, argued that our entire understanding and knowledge of the world is bound to our language and – denying any objective meanin or any actual reference of language to 'the world' – that it is of essentially metaphorical nature. The biologist UEXKÜLL (1934) argued that different species live in different worlds since their modes of cognition are structured differently. CASSIRER (1967) draws on the findings of UEXKÜLL and develops the idea that the world we consciously live in is essentially a symbolic world. The structure of this world does not so much depend on the 'outside' world rather than on the ways humans interact socially by means of symbolization. SAPIR (1949) and WHORF (1956), furthering the idea of linguistic relativism, also contributed substantially to our understanding of the role of language in the construction of our world. It is warranted to say that almost the entire philosophy of the 20th century was more or less concerned with the relationship between language and cognition.

With this history in mind it does not come as a surprise when researchers who were concerned with the linguistic representation of knowledge about the world called their constructs *ontologies* (e.g., Gruber, 1993; Guarino, 1995). But what has often been ignored is that these researchers are well aware of the differences between *ontologies* they construct and *ontology* in its philosophical sense: "The word 'ontology' seems to generate a lot of controversy in discussions about AI. It has a long history in philosophy, in which it refers to the subject of existence. […] In the context of knowledge sharing, I use the term ontology to mean a specification of a conceptualization. That is, an ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents. This definition is consistent with the usage of ontology as set-of-concept-definitions, but more general. And it is certainly a different sense of the word than its use in philosophy. […] [A]n ontology is a specification used for making ontological commitments. […] Practically, an ontological commitment is an agreement to use a vocabulary […] in a way that is consistent (but not complete) with respect to the theory specified by an ontology" (Gruber, 1993). Hence, *ontologies* are linguistic conventions that do not tell us anything about the outside world (e.g., Quine, 1961).

Taking linguistic relativity seriously, the play of language structures our (symbolic) world. We use language to objectify our experiences, thereby making it possible to communicate these experiences even if they lie in the past. Objectification also enables us to project potential future experiences, and to communicate these projections (Berger and Luckmann, 1966). If language is so closely knit to our experiences it comes as quite natural to understand language as a means of representation of our experiences. Yet, there is another feature of language we have to take into consideration: The meaning of linguistic expressions is not fixed; symbols are multivalent. In short, we use the same expression to express different meanings. Quite often objectification has been confused with objective meaning of linguistic expression.

If GRUBER understands *ontology* as a description or a specification of conceptualizations available to an (artificial) agent then we must be aware of the fact that an artificial agent does not conceptualize. Agents only command over a linguistic structure, not over conceptualizations. The concepts always remain in the realm of the human mind.

If we are about to develop an ontological foundation for information systems analysis and design we have to differentiate between the two distinct meanings of *ontology* depicted above. Referring to the BUNGE-WAND-WEBER ontology, this distinction is quite obvious. On the one hand we are familiar with all the constructs that are descriptions or specifications of conceptualizations (e.g., Wand & Weber, 1990a, p. 64). Thus, these constructs are parts of an ontology – according to

GRUBER's definition. On the other hand, we are familiar with the claim that these constructs are the 'things' that make up the world (Wand & Weber, 1988, pp. 213 ff.). This is a claim that belongs to the realm of philosophical ontology. And it is this claim that is highly questionable since it is based on a rather positivist philosophical position that not many would subscribe to these days (for some critical self-reflection see, Wand et al., 1995; Weber, 1997a, pp. 174 ff.). According to this position, an ontological model is regarded as a representation (mapping) of the 'true' reality, i.e., given perceptions. This representational notion of "model" presupposes a direct relationship between the model (the representation) and the model source (the original). A model is "good" or "true" if it corresponds with reality – the essence of the *correspondence theory of truth*. Accordingly, for the development of an ontological foundation for ISAD it is decisive to 'find' the true objects and relationships in *the* world. So far nobody knows how to do this. This is not a problem per se. Paraphrasing KANT (1787, Bxl) and HEIDEGGER (1962), the "scandal" is that there are still people around who try to figure it out.

(In contrast to BUNGE, WAND and WEBER are very vague about their philosophical assumptions. On the one hand, they refrain from naïve realism and adhere to a somewhat 'relaxed' positivism – perceptions are considered as "given" and as prone to error. On the other hand, they write about formal schemes that are needed to represent the real world (Wand & Weber, 1988, p. 214). In addition WEBER claims that – for the development of an ontological foundation for ISAD – it does not matter whether one adheres to objectivism or subjectivism. Yet the very idea of an ontological foundation that is based on BUNGE's ontology only makes sense if one adheres to BUNGE's philosophical position. Conclusively, it seems that WAND and WEBER are somehow stuck in the middle: they (most likely) know that realism is hard to sell these days but they need realism in order to make sense of their approach.)

Summing up, the effort geared towards the development of an ontological foundation for ISAD will only be fruitful if we dismiss the idea of an ontological foundation in the classical philosophical (or metaphysical) sense. Our symbolic world, structured by means of language and symbolic social interaction, is actually a plurality of worlds. Therefore, one might recommend that the followers of BUNGE, WAND, and WEBER should not adhere to the ontological, epistemological, methodological, and anthropological position held by BUNGE. Rather, it seems to be more promising to understand "ontological foundation" in the sense of GRUBER. The constructs provided by the BUNGE-WAND-WEBER ontology do not need to be grounded in some metaphysical theory. They might serve us well if we understand them as descriptions or specifications of conceptualizations. If we commit to this 'ontology' we commit ourselves to a vocabulary and a grammar that might or might not be useful to be used when we speak about 'the world.' We will know if we try to express our conceptualizations by means of this 'ontology.' If it does not serve our purpose we do not have to change our worldview – changing the vocabulary and the grammar will suffice. The notion of linguistic relativism will help us to understand why people understand an 'ontology' differently, or, in other words, why they attribute different meanings to one and the same 'ontology.' And, it will also direct us to a question that especially needs our attention: how do we develop conceptualizations that are at least compatible in such a way that we are able to communicate by means of an 'ontology' we have subscribed to?

SUMMARY AND CONCLUSION

The persistence of the software crisis – budget overruns, exceeded time frames, not meeting user's requirements, and total failure of information systems development projects – provides a host of motivations for the reconsideration of the state-of-the-art in information systems development. In order to overcome these highly undesirable results it is widely believed that the development of more rigorous theoretical foundations for information systems development is the key to success. One approach that has gained considerable attention during the last two decades is the development of ontological foundations for information systems analysis and design.

Quite in contrast to the general lack of interest in philosophical issues of information systems, *ontology* has become an inspiring source for information systems research and practice. Understanding information systems as essentially representational systems, i.e. as systems that represent knowledge about certain domains, ontology is largely being used for the identification or the definition of that what constitutes these domains. Thus, information systems research is more interested in the ontological question "what exists?" rather than in the question "what does it mean to exist?" – a preference and a negligence with considerable consequences.

It was the linguistic turn in analytical philosophy that brought the language dependency of all knowledge to our attention. Among others, HUMBOLDT, CASSIRER, SAPIR, WHORF and the mature WITTGENSTEIN argue that our access to the world is bound to language and that there is no way to transcend our knowledge beyond the means provided by language: "*The limits of my language* mean the limits of my world." (Wittgenstein, 1922, § 5.6). With the linguistic turn we have dismissed classical ontology. 'Modern' ontology is bound to language and the question for existence has been turned into a question of ontological commitment. With QUINE (1961): "To be is to be a value of a variable within a given theory."

This understanding of ontology is accompanied by the acceptance of the existence of multiple ontologies and the reduction of ontology to the study of language. The problems associated with everyday language were the starting point for the development of formal languages which in turn provide the basis for the development of formal ontologies. But formal languages (and formal ontologies) do not help to overcome the problem of subjectivity and linguistic relativism. The constructs of formal languages have per se no meaning in our "life-world" (Lebenswelt). Formal semantics do not tell us anything about 'our' world, that is, a world of informal languages. Their meanings are derived from symbolic social interaction and are always relative to *communities of practice*. It is only in such communities that objectifications by means of language develop a stable yet not fixed meaning that enables the members of the respective community to communicate efficiently and effectively. If we intend to say something about 'the world' by means of formal ontologies, we have to develop a common language practice that eventually will lead to the desired stable meanings. So far, this problem has hardly been addressed in the relevant literature.

In this contribution it has been argued that the restricted scope of discourses on the ontological foundation of information systems analysis and design is partly due to the negligence of well-documented debates within the domain of philosophy. By using the example of the BUNGE-WAND-WEBER ontology it has been shown that a broader scope eventually helps to understand and to overcome self-inflicted cognitive constraints. If we focus entirely on formal aspects of the ontological foundation of ISAD we are prone to fall victim to the error of the third kind, i.e., finding the right answers to the wrong questions. For example: why bother with the evaluation of modeling grammars? If we are convinced of an 'ontology' then why not develop a modeling grammar from scratch based on this very 'ontology?'

Current research on the evaluation of modeling grammars in the context of ISAD has provided proof of the usefulness of formal ontologies for certain purposes (e.g., Green & Rosemann, 1999; Milton et al., 2000; Fettke & Loos, 2003). But we need to keep in mind that such a proof only proves that one axiomatic system – a formal ontology – conforms to another axiomatic system – another formal ontology, or that it does not. We have no proof that the 'axiomatic reference system' – the 'ontology' – is suitable if we want to express something about 'the world.' And, we still have to prove that the analytical approach toward the development of the axiomatic reference system exemplified by the BUNGE-WAND-WEBER ontology is superior to, e.g., a phenomenological or a hermeneutical approach.

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