# Shifting the ontological foundations of accounting's conceptual scheme

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## Abstract:

*The purpose of this paper is to establish the nature of the need for a new accounting conceptual scheme and provide the framework for taking a managed approach to this change. This paper firstly reviews the nature of the need for a radical shift in the foundations and framework of accounting's conceptual scheme. It touches upon how the existing uses of ontological analysis within accounting information systems research do not address this need. It then outlines how a more philosophical approach to ontological analysis provides a process for starting the shift in the foundation. And illustrates how the process will work with some examples.*

## Introduction

The last century's revolutionary developments in information technology, particularly in computing, have led to many significant changes, and still continue to do so. There is the beginning of a recognition that they may well lead to a new accounting conceptual scheme[1]. There are proposals for changes afoot[2] – though what the final outcome will be is unclear. The overall purpose of this paper is

[1] Where this is the framework of concepts used by the accounting community to think about accounting.

[2] See for example, Geerts and McCarthy (2002) *An Ontological Analysis of the Primitives of the Extended-REA Enterprise Information Architecture* say on p.2 "many scholars consider it [the REA model] a more solid foundation for the enterprise information systems of the future than the traditional double-entry framework it attempts to supplant". Similar points are made in Walker and Denna (1997) *Arrivederci, Pacioli? A new accounting system is emerging.* and Andros, et al. (1992) *Reengineer your accounting, the IBM way*.

to promote work on facilitating a conscious managed approach to this change. Firstly by explaining why there is a need for change, secondly by providing an insight into what kind of thing the new scheme needs to be and thirdly suggesting a process for making one of the first steps – the re-engineering of its foundations.

It firstly examines the nature of the changes. It shows how similar changes in the past provide an insight into what the accounting changes are likely to be. It explains why the changes are likely to involve both a significant precisification and a radical shift in the foundations and framework of accounting's conceptual scheme. (It also explains why the new foundations will probably provide a much better support for current and future business changes.)

It secondly proposes a process – philosophical ontological analysis – for systematically carrying out the first part of the radical shift – the re-engineering of the foundations. It outlines what this is and illustrates how it will lead to the predicted radical shifts, using the basic bookkeeping foundations of accounting's conceptual scheme.

The work reported on here has been in gestation for some time. A brief report of an initial attempt at re-engineering the accounting paradigm was given some time ago in the Epilogue to (Partridge 1996), see §2 – *The accounting paradigm's debit and credit pattern*, §3 – *Accounting's ledger hierarchy*, and §4 – *Developing a new object-oriented accounting paradigm*. This drew upon over half a decade of commercial work re-engineering enterprise systems using the REV-ENG methodology. This paper presents a significantly updated perspective taking account of more recent work – particularly on the context for the re-engineering.

## Current ontological analysis initiatives in accounting information research

There are two relevant ontological analysis initiatives within accounting information systems, which I will call the Wand/Weber[3] and the McCarthy/Geerts[4] initiatives. These both make useful steps in the right direction. The Wand/Weber initiative explicitly draws upon the work of Mario Bunge (Bunge 1974). Its focus is on the needs of conceptual modelling and is not directed towards a specific model of

[3] See, for example, Wand and Weber (1989) *An Ontological Evaluation of Systems Analysis and Design Methods*.

[4] See, for example, McCarthy (1982) *The REA Accounting Model*.

accounting. The McCarthy/Geerts initiative has developed a specific model of accounting called (in (McCarthy 1982)) the 'REA Accounting Model'.

The Wand/Weber initiative started with an existing ontology (Bunge's) and applied this to conceptual modelling. The work in this area has been using the framework of Bunge's ontology to organise the way modelling is done – rather than investigate the ontological principles that underlie Bunge and others' ontological analysis.

The McCarthy/Geerts initiative grew out of data modelling. The need for ontological support was subsequently recognised and, in (Geerts and McCarthy 2000), it was investigated how the model (now called the REA enterprise information architecture) conformed to John Sowa's ontology (Sowa 2000).

More recently Weber has commented on the importance of ontology for his initiative (Weber 2002) – making several points relevant to this paper, in particular the six pitfalls in current work:

1. "We undertake large amounts of work to build domain-specific and application-specific conceptual models under the mistaken belief that we are doing ontologically based conceptual modelling research."
2. "We use poor-quality ontological theories as the basis for our conceptual modelling research."
3. "We proceed in our research with an expectation that results will come easily and quickly."
4. "We continue to mix conceptual modelling issues with data modelling issues."
5. "We use imprecision in our language as an excuse for imprecise conceptual modelling."
6. "I continue to model information systems artifacts in a domain rather than the underlying phenomena they represent."

As Weber notes much of the work on producing "high-quality ontological theories" has been done in philosophy[5]. However both initiatives have chosen to start from work that is not currently mainstream in the philosophical discipline, and an approach that does not encourage philosophical ontological analysis. Mario Bunge's work, though admirably suited, as Wand/Weber appreciate, for organising

[5] The recognition that philosophical ontology is useful has been around for some time. Mealy (1967) *Another Look at Data* said it was essential. Kent (1978) *Data and reality* makes a similar point. However, it was only in the 1990's that this significant work started being done.

conceptual modelling is not in the philosophical mainstream. And the very qualities that attract Wand/Weber – its clear simple system – do not encourage questions about why the structure is the way it is. This is exemplified in their work, which is marked by a complete acceptance of the Bunge system. The ontology chosen in (Geerts and McCarthy 2000) as a basis for testing conformance does not belong to the philosophical mainstream. Sowa's ontology has its origins in computer science and knowledge representation; though it is strongly influenced by philosophical work, in particular, Sowa's personal interpretation of the philosopher Charles Peirce. As already noted, the paper's focus is on conformance, not subjecting the elements of its model to ontological analysis – mainstream or otherwise.

If one looks for the kind of analysis found in mainstream philosophical ontology in these two initiatives, one finds relatively little. Identity is a central concern for philosophical ontology, particularly identity over time and how this relates to spatio-temporal extension[6]. Similarly mereology. There is little or no mention of these in the papers from either initiative. As this paper will show later, sensitivity to these is vital to clarify the foundations of accounting.

Specific examples may help to make this point. Consider (Weber 2002)'s comment that "an order is simply a widely accepted information systems artifact that stands for a state change in a customer." John Seale's more penetrating analysis of socially constructed objects (Searle 1995) would take a different view – regarding the order as a social institution. And this is more in accord with common sense. There are also issues about the notion of customer. In my paper (Partridge 2002f), I question the identification of the notion of person (or company) with customer, which Weber appears to make with his comment. This is an illustration of the point that Weber himself makes (Weber 2002), that there is still a need for the attempts to model (analyse) accounting to take on board basic lessons learnt in philosophical ontology and apply them to their domain.

As a specific example from the McCarthy/Geerts initiative consider their definition of agent. They distinguish between internal and external agents. However, this categorisation involves taking the position of one of the participants in the transaction. What is internal to one participant is external to the other. Ontology is intended to be an objective 'view from nowhere'; internal and external are

[6] See, for example, Sider (2001) *Four-dimensionalism : an ontology of persistence and time*.

subjective and indexical and have no real place in at the core of an ontology[7]. These examples help to show, as Weber noted, that the ontological analysis work is neither easy nor will it produce results quickly.

The lack of a mainstream ontological analysis in these approaches is, in part, explained by the goals of the initiatives neither of which are directed toward a radical re-engineering of the current accounting conceptual scheme. And, in part, by their origins in the discipline of accounting information systems.

**Asking what history can teach us**

This paper has a different goal from these initiatives and so suggests a different approach. It suggests that our efforts need to be guided by an understanding of the context and nature of the need for change. That it makes sense to start by stepping back and asking what is driving this need for change and what the new conceptual schema will look like. This is particularly true as answering these questions involves a number of different disciplines.

Obviously, a prime driver for change is the revolution in information technology, particularly the development of computing. However, to appreciate the extent of this one needs to recognise the extent to which the current scheme is a product of the old paper and ink technology. Then it becomes clear how much of the current scheme needs to be aligned with the new technology. The question then is: what form will this re-alignment take? Here studies of other similar historic re-alignments (revolutions) provide some clues. Studies in 'orality and literacy' and the 'philosophy and history of science' reveal the likely general characteristics of the shift and the new scheme.

**Accounting - bookkeeping - based upon old technology**

The emergence of accounting (and its conceptual scheme) is closely associated with the emergence of writing (an early information technology). Historians tell us that writing developed in Ancient Mesopotamia millennia ago to help people manage the accounts of the developing city-states[8]. They

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[7] For more on indexicality see Partridge (2002e) *The Role of Ontology in Semantic Integration*. For details on the usefulness of avoiding it in data modelling see Inmon, et al. (1997) *The data model resource book* – where it is called the 'I' perspective. The overall REA notion of agent seems to need further ontological analysis – for an example of the kind of analysis see Partridge (2002d) *STPO - A Synthesis of a TOVE Persons Ontology*.

[8] See, for example, Nissen, et al. (1993) *Archaic bookkeeping*.

developed systems of budgeting and accounting for resources that both supported the emerging social structures and enabled more complex structures to develop.

The current accounting conceptual scheme has it roots in a more recent development. The introduction of printing in the late fifteenth century prompted a number of books on accounting[9] – describing various different systems. It also prompted Europe's standardisation on the one of these most suited to the then current technology – the system described in (Pacioli 1494)[10]. The influence of paper and ink technology is plain in the book's text. For example, in Chapter 2, Pacioli writes "The businessman must then prepare his Inventory in the following way: First of all, he must *write* on a sheet of *paper* or in a separate *book* …".

Pacioli's system also shows the constraints of this technology. One of its key features was the use of two books: the Journal to record the event and the Ledger to record the entries – hence its name 'double entry'. From the modern perspective of computing technology we can see this as constructing two different views over the same data[11]. The use of two books created the need to correlate the two views. Pacioli describes how this is done: "In the left margin, next to the [journal] entry place the page numbers where the debit and credit entries are to be found, the debit above the credit below. … When this is done the accounts can easily be located in the Ledger." These operations are unnecessary in a modern computing system based upon views over data.

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[9] Littleton (1933) *Accounting evolution to 1900* on p.23 notes some of the early books: Account Keeping – Pacioli, 1494; Reckoning Book – Schreiber, 1523; Book Keeping – Gottlieb, 1531; Keeping the Reckoning called Debtor and Creditor – Oldcastle, 1543; Accounting Books in the Italian Manner – Ympyn, 1543; Double Bookkeeping – Schweiber, 1549; Keeping Books of Account – Mennher, 1550.

[10] The chapter *Particularis De Computis Et Scripturis* (Details of Accounting and Recording) in the book *Summa de Arithmetica, Geometria, Proportioni et Proportionalita*. The system is one that, as Pacioli noted, had been used by Venice merchants for hundreds of years. So printing was not a key factor in its development – just in the standardisation upon it.

[11] Goody (1977) *The domestication of the savage mind* p.89 notes that Pacioli's system is an example of the general problem of sorting lists within writing technology.

**Orality and literacy studies.**

The radical shift from oral to literate culture – from speaking to writing (and listening to reading) – has been studied[12], as well as the later shifts due to the introduction of paper and printing. A constant theme in these studies is the way changes in technology lead to radical changes in the conceptual structure[13]. For example, writing enabled the emergence of radically different legal and religious systems – as well as the development of science.

The studies show that the shifts had two common features: a vast increase in the amount of information and the new technology's need for significantly increased formality and precision. These two features converged, in so far as the need to radically improve the way the increased volume of information was handled typically involved a significant increase in precision – usually entailing the introduction of more precise distinctions.

The two features are clearly at work in the current information revolution. There has been a vast increase in the amount of information and computing technology's need for significantly increased formality and precision is well known. The introduction of a more precise framework of distinctions has yet to happen for most conceptual schemes – including accounting.

**History and philosophy of science studies.**

One area where shifts in conceptual structure have been documented and studied extensively is science. This makes it a fruitful source of clues as to what the accounting revolution may produce. One particularly useful source is (Kuhn 1970)'s description of the nature of scientific revolutions.

He notes the importance of what he calls paradigms that fix a world view for the practice of normal science in a community. (We can see Pacioli's book as the initial specification for the paradigm that

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[12] A good introduction to the subject is Ong (1988) *Orality and literacy*. A more recent introduction is Olson (1994) *The world on paper.* More specialised accounts include Clanchy (1993) *From memory to written record, England 1066-1307* and Eisenstein (1983) *The printing revolution in early modern Europe.*

[13] Olson (1994) *The world on paper* proposes, contrary to popular conception, that it is radical shifts in conceptual structure that enable radical developments in technology. However, he accepts that this development then go onto lead to further radical changes in conceptual structures.

underlies the current accounting conceptual schema.) He notes that as scientific theories evolve they tend to become more unwieldy, more complicated, less explanatory and less fruitful.

Scientific revolutions are a response to this. Historically, they often involve a breakdown of normal science and a return to fundamental questions, often ones that were 'settled' long ago. They are usually a response to well-known inadequacies of a theory in the light of well-known data rather than to new experimental results – Copernicus, Newton and Einstein are good examples. (The questioning of Pacioli's restriction of the ledger to monetary entries is an accounting example of a well-known inadequacy.)

The response typically involves a radical shift in the underlying paradigm, which re-arranges the existing knowledge into a very different pattern – rather than introducing new knowledge. As Kuhn notes[14], this change is like seeing the same world in a different way and quotes other historians who have made similar comments: (Butterfield 1949) on pp.1-7 describes it as "picking up the other end of the stick", a process that involves "handling the same bundle of data as before, but placing them in a new system of relations with one another by giving them a different framework".

**The probable characteristics of accounting's shift**

These studies give us a picture of some of the probable general characteristics of the shift in accounting's conceptual structure.

- The alignment with the new information technology is going to require significant increases in precision.
- The current radical changes in information technology are likely to lead to equally radical changes in conceptual structure.
- The radical shift will start with the foundations of the conceptual structure.
- This shift in the foundations is likely to be a re-arrangement of what we already know in response to well-known inadequacies.

[14] Kuhn (1970) *The structure of scientific revolutions* § The Response to Crisis, p.85.

## Identifying accounting specific details

This historical analysis gives us some general characteristics that we now translate into accounting specific details. It reveals that the core of the shift is going to be a re-arrangement of what we know about the accounting conceptual structure, starting with its foundation, whose elements we now pick out and focus on. It also reveals that the re-arrangement is going to respond to well-known inadequacies. We pick out a couple of the most salient of these inadequacies for the foundation elements.

### The elements of the foundation

What are the elements at the foundation of the current scheme? At the core of accounting is bookkeeping and the basic elements of this can be identified even in Pacioli's original text.

The obvious starting point is the accounting books: the journal and the ledger. Then there are the divisions in the books. Journals are divided into days and ledgers into accounts. Then there are the entries that are made in these divisions: journal entries and ledger entries. We could identify more elements, but these are sufficient to illustrate our analysis. It is our knowledge of these elements that the new scheme has to 're-arrange', showing them in a different light.

### Well-known inadequacies and well-known – historical – facts

A straightforward way of identifying some well-known inadequacies of (facts about) the current scheme is to compare it with the other competing schemes it originally triumphed over[15]. One such scheme is (Manzoni 1534) who notes that:

> "the four principal things appertaining to buying, selling, receiving, paying, exchanging, lending and gifts are:

1. The one who gives
2. The one who receives
3. The thing given
4. The thing received" [16]

[15] Recall Einstein's re-opening of the debate on absolute and relative space between Newton and Liebnitz.

[16] Translation from p.47 of Littleton (1933) *Accounting evolution to 1900*.

There are a couple of obvious differences between it and Pacioli's scheme. Firstly, it recognises (as many other schemes at the time did) the non-monetary element of the transaction. This is now clearly recognised as a shortcoming of Pacioli's scheme and is remedied, for instance, in the REA framework. Secondly, it explicitly recognises the proprietor, which is implicit in Pacioli's.

**Increasing the precision of our understanding**

There is a clear recognition in accounting of a need to represent the business sufficiently precisely. This is shown in the traditional accounting claim that the accounts present a 'true and fair picture' of the business. In (Dunn and McCarthy 1997)'s analysis of the drivers for proposed accounting conceptual schemes this is called (on p.7) the semantic orientation: where "[t]he objects in this conceptual model are required to correspond closely to real world phenomenon", which can sensibly be differentiated as conceptual objects and business objects.

The foundational elements identified earlier are conceptual objects, which represent business objects. The historical analysis above suggests that the shift to a new scheme will set higher standards of precision. In this case, it is not so much that the conceptual objects will be more precise in themselves, but that they will provide a more precise representation of the business objects. A useful first step towards this is to get a clearer picture of what the business objects, referred to by foundation (conceptual) elements identified earlier, are.

**A clearer picture of the conceptual objects**

Let us start by clarifying the structure of relationships between the foundational conceptual elements identified above. The books originally were where the accounting data was stored – in both a journal and a ledger book. In modern applications, these are either tables on a database or views over them. Divisions are the way the data are divided in the books: the journal is divided by days and the ledger by accounts. Inside these divisions the entries are stored, journal entries in the journal's day divisions and ledger entries in the ledger's account divisions. Additionally the ledger entries are linked back to their corresponding journal entry. This structure is shown below in Figure 1.

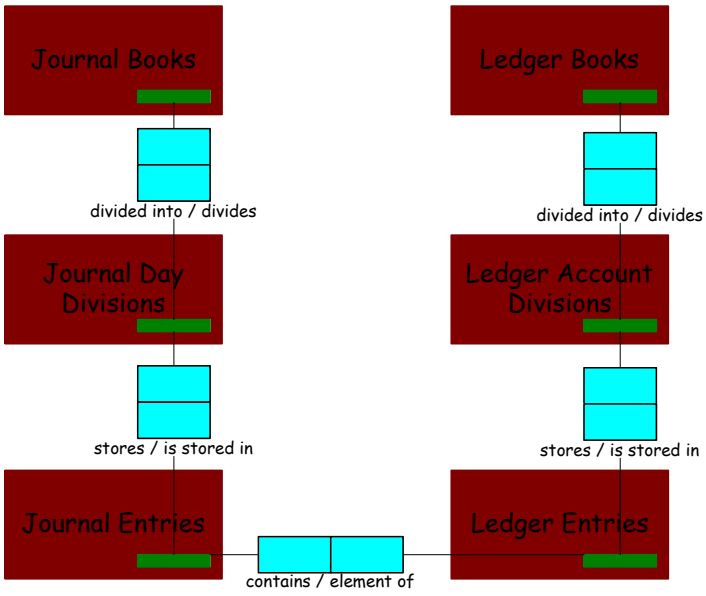


**Figure 1 – The accounting foundational conceptual elements**

These conceptual objects and their relations refer to and reflect the business objects and their relations that they account for.

### Clarify our current understanding of the business objects

A necessary first step in developing a more precise understanding of the business objects, is to clarify our current understanding of what they are. As an illustration, we now make a simple analysis of what business objects are represented by the conceptual objects in Figure 1.

We start with the 'journal entries' as it is clearest what these refer to. These record 'business transactions'. The corresponding 'ledger entries' are the accounting representation of the relevant 'accounting movement' elements of the transaction. This implies that relation between the transaction and the movement, represented by the link between the journal entries and the ledger entries, is a kind of mereological whole-part relationship.

It is less clear what the books and divisions conceptual types reflect – they seem to be more mechanisms for organising the data than reflecting business objects. However, with a little analysis an educated guess can be made. The individual books can be seen as representing certain kinds of objects for a particular accounting entity. (Notice that the existence of a book implicitly assumes the existence of an accounting entity.)

An individual journal book can be seen as representing the collection of business transactions to which the accounting entity is a party. The general journal book conceptual type can be seen as representing the collection of the individual 'journal book' objects (in other words, a collection of collections of business transactions) – a sub-type of business transaction types. Let's call this an Accounting Entity Transaction Type.

An individual ledger book can be seen as the collection of accounting movements for those transactions. Similarly, the general 'ledger book' conceptual type can be seen as representing the collection of the individual ledger books –a sub-type of the general account movement types. Let's call this an Accounting Entity Movement Type.

A similar manoeuvre can be made for the divisions. An individual journal division in a journal can be seen as representing the collection of transactions recorded on that particular day for that particular accounting entity. (Notice that this implicitly assumes the existence of the type day.) This is a sub-collection of its corresponding Accounting Entity Transaction Type instance. Journal day division represents a collection of these day collections of transactions – whose instances will be sub-types of the instances of the general journal book type. Let's call this an A/C Entity Day Transaction Type.

An individual account division in a ledger can be seen as representing the collection of movements that have been classified for that particular account for the particular accounting entity. This is a sub-collection of its corresponding Accounting Entity Movement Type instance. The general 'ledger account division' conceptual type represents the collection of these day collections of transactions – whose instances will be sub-types of the instances of the general journal book type. Let's call this an A/C Entity Account Movement Type. The division into accounts is based upon a variety of criteria that are not explicitly reflected in the structure of these foundation elements. There are too many of these to analyse and represent them here.

These business objects and their relations are shown diagrammatically in Figure 2 below, with a box surrounding the explicitly represented business objects.

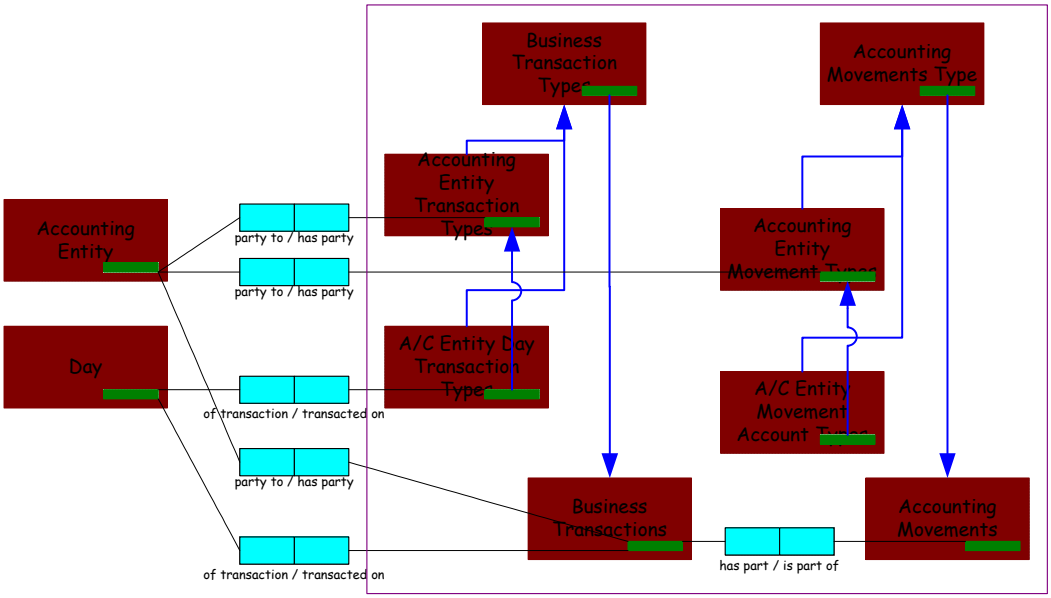


**Figure 2 – Business objects represented by the accounting foundational conceptual elements**

It is clear from the analysis reflected in this diagram that the transactions and movements are fundamental. The other explicitly represented business objects are really collections of transactions and movements grouped together on the basis of other objects (in the case of the accounts classification these other objects are not shown). In the light of this it is reasonable to relegate the collections from our foundational elements list and promote the objects upon which they are based – which give us this revised (partial) list of foundational business objects:

- business transactions,
- account movements,
- accounting entity, and
- day.

## Explaining ontological analysis

Though the forgoing analysis gives us some idea of what needs to be analysed, it does not suggest a specific process. Current accounting practice does not have such a process, understandably, as it is not focussed on this kind of task. The solution needs to come from outside the discipline. This paper proposes a process of ontological analysis that is informed by a metaphysical framework. The notion that a philosophical approach can help with analysis in general is not new - (Weber 2002), for example, makes this point, noting that work is only starting in this area. What is different here is the application of critical philosophical metaphysical analysis rather than the relatively uncritical use of ontological

frameworks (which characterises the Wand/Weber and McCarthy/Geerts initiative). This is vital given the goal of re-engineering conceptual foundations – as this, of its nature, requires an incisive critical analysis. There is an issue of determining what elements of the philosophical apparatus will turn out to be appropriate. To some extent this is an empirical question, where the answers are given in terms of what works. The process aims to build upon the experiences reported in (Partridge 1996), on using this method to re-engineer IT systems.

Before we look at the details of ontological analysis, there is a need put things into context and explain what ontology is and how it is used in this approach. This is in part because it has always been, and still is, an esoteric discipline. It is also because of the novel way that this discipline is being harnessed and applied in IT, and now here in accounting. The explanation starts by clarifying the use of some basic terms: firstly, ontology and semantics.

**Ontology**

Central to the ontological analysis approach is the traditional philosophical (metaphysical) notion of ontology – where this is "the set of things whose existence is acknowledged by a particular theory or system of thought."[17] Here the set of things is not just restricted to simple entities, it includes things of every type: for example, it can include relations and states of affairs, if these are deemed to exist.

This view was famously summarised by Quine, who claimed that the question ontology asks can be stated in three words 'What is there?' – and the answer in one 'everything'. Not only that, but tongue in cheek, he also said "everyone will accept this answer as true" though he admitted that there was some more work to be done as "there remains room for disagreement over cases." [18] Quine's glib description captures the common intuitive position in many disciplines, where it is unthinkingly assumed that the answer to the question "What is there – in this discipline?" will be the set of things that the discipline deals with.

Some care needs to be taken to distinguish this traditional metaphysical use of the word 'ontology' from one that has recently developed within Computer Science. Here an ontology is regarded as a

[17] E. J. Lowe in the Oxford Companion to Philosophy.

[18] In W.V. Quine's *On what there is* (1948), Review of Metaphysics, Vol. II, No. 5, reprinted in *From a logical point of view* (1961).

"specification of a conceptualisation" (Gruber 1993) and is being applied to a wide range of things, including dictionaries. The Gruberian sense is similar in many respects to the notion of conceptual schema described in ANSI/X3/SPARC (Tsichritzis and Klug 1978). This is intended to reflect how we conceive of the world – which is, in important ways, not the same as what our conceptualisation commits to existing in the world (or what things make the conceptualisation true).

This 'conceptualisation' sense of ontology does not give a fine-grained enough tool for the type of task discussed here. For example, by regarding a conceptual scheme as simply the ontology – it cannot make sense of talking about the ontology underlying the scheme[19]. Therefore, the ontological analysis we are discussing here will focus not on accounting's conceptual structure but on the 'the set of things whose existence it acknowledges' – its (metaphysical) ontology.

**Semantics**

Along with the traditional philosophical sense of ontology there is a related notion of semantics – where this is the relationship between words (and concepts) and the world – the things the words (and concepts) describe[20]. This needs to be distinguished from the different, but related, sense of the word in linguistics where it means the study of meaning[21].

These notions of ontology and semantics are now used to describe what an ontological model and a canonical scheme are. Finally two other relevant notions are described: categorical ontology and epistemology.

**Ontological model**

An ontological model is a model that directly reflects the ontology. There is a simple semantics where each object in the ontology has a direct relationship with the corresponding representation in the

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[19] Similar criticisms of the 'conceptualisation' approach are made by Barry Smith and Chris Welty in their introduction the *Proceedings of the international conference on Formal Ontology in Information Systems - 2001*.

[20] Or as Nelson Goodman put it in the Introduction to Quine's lectures published as *Roots of Reference* – "… an important relation of words to objects – or better – of words to other objects, some of which are not words – or even better, of objects some of which are words to objects some of which are not words."

[21] "Semantics – the study of meaning" from the Concise Oxford Dictionary of Linguistics, 1997.

model[22]. One of the characteristics of an ontological model is that the representations in it can be regarded as the names of the objects in the ontology – in Fregean terms as reference without sense (in Millian terms as denotation without connotation). In (Marcus 1993), Ruth Barcan Marcus (explicitly following in the footsteps of Mill and Russell[23]) calls this 'tagging'.

**A canonical scheme**

An ontological model can be seen as a canonical representation scheme. The notion of a canonical form comes from mathematics. This has a general notion of a normalisation procedure, which consistently transforms objects (for example, matrices) into one of a set of canonical forms. Where two objects are normalised into the same canonical form they are regarded as equal (relative to the normalisation procedure and its canonical forms). In relational database modelling there is also a well-known normalisation procedure that leads to a canonical form usually called the normal form.

One can see that ontological analysis is a kind of normalisation process for representations that leads to a canonical form in the shape of an ontological model. This normalisation process strips away any semantic divergences from a model – revealing an ontological model.

**Categorical ontology**

There is tradition that starts with Aristotle[24] of not only ordering the types in an ontology into a taxonomy, but also explicitly including, at the top level, the major formal categories of entities (what can be called, more pompously, the types of existence). As a matter of principle, all the various lower level types fall under one or other of these top level headings. Following (Thomasson 1999), I will call this a categorical approach.

Computer science has picked up on the value of a categorical ontology. For example, John Sowa, in his latest book ((Sowa 2000) on p.51), states that "A choice of ontological categories is the first step in designing a database, a knowledge base or an object oriented approach."

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[22] This is called *strong reference* within the REV-ENG Methodology described in Partridge (1996) *Business Objects: Re - Engineering for re - use*.

[23] Mill (1848) *A system of logic* and Russell (1919) *Introduction to mathematical philosophy*.

[24] See Aristotle *The categories*.

**Core accounting ontology**

The ontology produced for the new accounting schema can be divided into a number of layers. At the top are the formal categories[25]. Underneath this is the core accounting ontology. A core ontology – as (Breuker, Valente et al. 1997) note – "contains the *categories* that define *what a field is about*." Where a "field is a discipline, industry or area of practice that unifies many application domains …". Determining the scope of core ontology is a practical matter – and is guided, as Breuker et al suggest, by how much a candidate category helps to provide a unifying structure. The key point is that given a 'field' such as accounting there are core categories that help to "define *what [it] is about*."

**Epistemology**

There are two reasons why it is useful to introduce the notion of epistemology here. Firstly to clarify by contrast the notion of ontology and secondly because the new accounting conceptual scheme will need to have an epistemology built on top of its ontology – as indeed will almost any conceptual scheme. The examples of ontological analysis in the later sections illustrate this.

In philosophy, ontology and epistemology deal with two different questions, which results in two different ways of looking at and analysing the world. Ontology is concerned about what exists – whereas epistemology is concerned about what is (or can be) known by someone[26]. For example, an epistemology would attempt to explain how we can know about a particular type of thing, such as colours. Whereas an ontology may well not be interested in this at all, but be interested in what ontological type colours are.

These two different approaches are both useful when specifying a system, particularly a computer application. A system (application) will make some ontological commitment – it will assume that certain things exist. These things are its ontology, which answers the question – what exists according

[25] In Partridge (1996) *Business Objects: Re - Engineering for re - use* this is called the framework level and an example of this for IT ontological analysis is given on pp. 276-8.

[26] Epistemology - The philosophical discipline that considers the nature, basis, and limits of knowledge. The Macmillan Encyclopedia 2001, © Market House Books Ltd 2000.

to the system. The ontological model will describe the structure of this. A system[27] will also have constraints on what it actually does (and can) know. These are described in its epistemology, which answers the question of what the system can (and must) know. Of particular importance for operational applications is describing what it needs to know before it can do something. An epistemological model will describe the structure of this.

Let us assume, simplistically, that in our conceptual scheme all humans are either male or female. Then we are ontologically committed to the existence of male and female types, which are sub-types of human and completely partition it. This is the ontology. Assume that we now wish to construct the epistemology for someone with our conceptual scheme who is pregnant but does not know the gender of their baby. The epistemology will need to accommodate a third sub-type for humans, gender-unknown. In other words, this epistemology has these three sub-types of human. Both ways of categorising the world are valid. However they serve different purposes and can, as in this example, give different results.

Epistemology's purpose lines up quite neatly with one of the key requirements in specifying a computer application, clarifying what it must know and what it does not need to know. This makes documenting the epistemology an essential element of the specification of a system – though it is not usually called given such a grand name.

In current practice, the epistemic perspective plays a more prominent role in computer specifications because the current state of database technology means that only the epistemology (and not the ontology) is reflected in a company's database. This is why the use of the terms 'mandatory' and 'optional' for attributes and the cardinality constraints upon relations in database contexts are usually from an epistemic (not an ontic) perspective.

From this brief outline it should be clear that our conceptual schemes need both an ontology and an epistemology. People need to be able to conceptualise that they do not know the gender of their unborn child, but that it has one. Unfortunately, due the constraints of current database technology, it tends to be the epistemology that is explicitly captured in the database.

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[27] In the case of a computer application this may be a network of applications, each with its own constraints upon what it can know.

## Ontological relativity and paradigms

It might seem that discovering the ontology underlying a scheme is a straightforward matter. Most communities have a broad agreement about the majority of the objects in their domains. For example, professional accountants broadly agree what transactions and accounting movements are. This is because they share a common conceptual scheme. This would seem to imply that modelling the objects in their underlying ontology is straightforward. Unfortunately it is not, because the consensus usually does not survive the rigour of an ontological analysis of the common conceptual scheme.

Ontology needs a paradigm to fix its world view, and there are a variety of paradigms with major structural (architectural) differences – this is known as ontological relativity[28]. Much of the variety can be characterised in terms of metaphysical, meta-ontological choices[29]. These choices help to characterise what kinds of things can exist – and how they can exist. They dictate the top level categories into which the rest of the things that exist fall.

Most communities have not consciously fixed on an ontological paradigm. They would not understand the meta-ontological choices and have difficulty in characterising the top level categories if they were to attempt to do this. The solution is for the ontological analysis needs to supply the ontological paradigm. Experience with ontological analysis has lead to the development of what is known as the business object paradigm, which is described in (Partridge 1996; 2002b).

## The Business Object Paradigm

Ontological paradigms can be characterised in two different ways, by:

- the metaphysical choices they embody, and
- the styles of analysis they lead to.

As often happens at this very general level these two are inter-related – this will become clearer in the exposition below.

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[28] Quine (1969) *Ontological relativity, and other essays* introduced this term.

[29] See Partridge (2002a) *Note: A Couple of Meta-Ontological Choices for Ontological Architectures* and also Chap. 1 – Meta-ontology of Van Inwagen (2001) *Ontology, identity, and modality*

To gain a good understanding of the paradigm it is essential to have a good grasp of the choices and styles[30]. However, for the example of ontological analysis below a grasp of one result of the choices is adequate.

**Spatio-temporal extensional identity criterion for elements**

At the root of this result is a proposal by Quine that greatly simplifies the analysis of identity. He suggested that identity is formally characterised for every entity on the basis of inheriting it from a top category – where all of these have a formal criterion of identity. Hence his slogan (Quine 1969) that there is 'no entity without identity'.

Within the business object paradigm, the identity criterion for the top category of elements is spatio-temporal extension. If elements have the same extension, then they are the same. In less technical jargon, if two things are always in the same place at the same time, then they are the same – otherwise they are different. As (Locke 1690) pointed out[31] some time ago, if two things have different beginnings (or endings) they cannot be the same thing.

**Styles of analysis**

The business object paradigm's styles are, like scientific styles, rooted in successful practice rather than arrived at theoretically. The meta-ontological choices that led to spatio-temporal extensionalism have a big influence – leading to a style called here extensional analysis.

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[30] This can be found in a number of places, including the longer report based upon this paper Partridge (2002c) *A new foundation for accounting*.

[31] Book II, Chapter xxvii, 1 – XXVII – Of identity and diversity – "… When we see any thing to be in any place in any instant of time, we are sure, (be it what it will) that it is that very thing, and not another, which at that same time exists in another place, how like and indistinguishable soever it may be in all other respects: … [O]ne thing cannot have two beginnings of Existence, nor two things one beginning, it being impossible for two things of the same kind, to be or exist in the same instant, in the very same place; or one and the same thing in different places. That therefore that had one beginning is the same thing, and that which had a different beginning in time and place from that, in not the same but divers."

The ontological analysis often starts with elements. An important style of analysis involves mapping out their spatio-temporal extension, in the form of space-time maps[32], in relation to other elements' overlapping extensions. The example analysis below demonstrates the utility of this.

**Ontological analysis of accounting's foundational elements**

The ontological analysis presented here[33] focuses on a few simple transactions. It develops a more precise understanding of the business objects that are involved and in the process re-arranges the traditional perspective of them. This helps to illustrate the points that the paper has made so far.

This new perspective is *not* offered as the solution – merely a step towards a solution. It needs to be severely empirically tested before it can be regarded as such. This has been done to an extent, as the analysis here is based upon similar work that have been done and tested over the years. However, further empirical checking is essential, and no doubt this will lead to further improvements.

The analysis focuses on the four foundational business objects and their three relations identified earlier, starting with accounting movements.

### A core bookkeeping object – accounting movement

Tradition regards an accounting movement as a movement across an account that either increases (a credit) or decreases (a debit) its balance. This can be illustrated with a simple transaction. Consider the purchase of a car for £10,000. Before the purchase the car is owned by Mr Smith and the £10,000 by Mr Jones. They make an agreement and, afterwards, the car is owned by Mr Jones and the £10,000 by Mr Smith. This would typically be accounted for in Mr. Smith's ledger with these two movements:

- Debit – Car Account - £10,000
- Credit – Cash Account - £10,000.

Two complementary movements would be made in Mr. Jones' ledger.

- Credit – Car Account - £10,000

[32] Typically in space-time maps – see pp.179-80 of Partridge (1996) *Business Objects: Re - Engineering for re - use* for an explanation and examples.

[33] For an analysis covering similar ground from a different perspective see the Epilogue of Ibid..

- Debit – Cash Account - £10,000.

These movements are representing the business situation described above. The question is what objects do they commit to existing. Within the business object paradigm, these objects will exist in space-time and we can map their extension.

Consider the car[34]. Before the agreement it was owned by Mr. Smith and after the agreement it is owned by Mr Jones. We can see this as two different ownership states of the car. The £10,000 has corresponding ownership states. The agreement terminates the first state and creates the second state. These are diagrammed in the space-time map below.

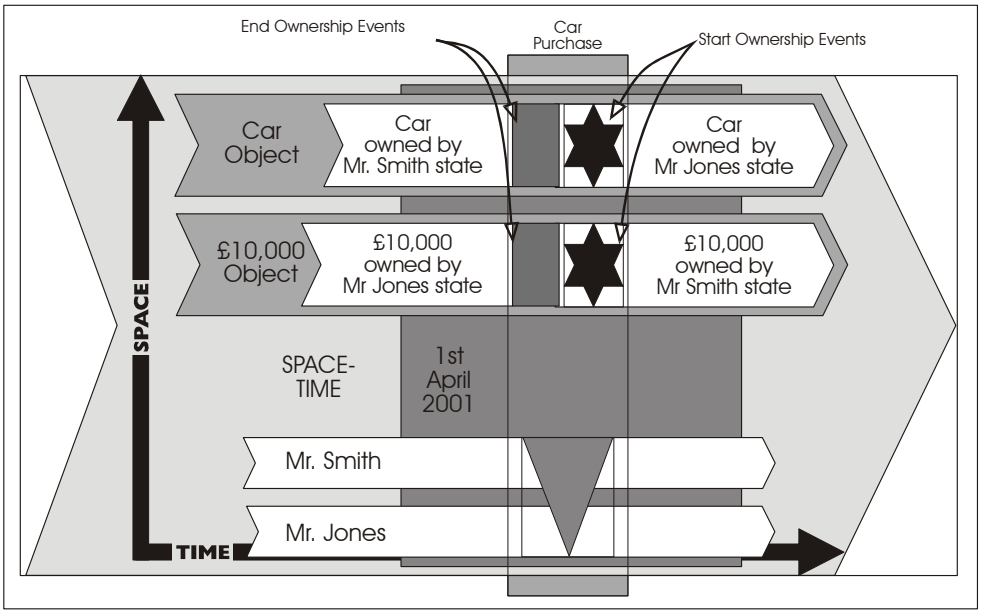


**Figure 3 – Ownership state events space-time map**

This gives us a different perspective on the situation. The closest thing to a movement would be the passing over of the £10,000. However, this physical movement is not enough in itself to change ownership. The money could be handed over for counting without any change of ownership taking place. One can easily imagine the ownership of the car changing without it moving at all. The objects that most closely correspond to the debit and credit are the start and end events of the ownership states, which result from the business transaction. There are four of these:

[34] This analysis has been simplified for exposition. It assumes that the transaction deals with the object itself rather than its property/ownership rights. This simplified analysis can be seen as a first step towards a more precise understanding.

- End – Mr. Smith's car ownership state
- Start – Mr. Jones' car ownership state
- End – Mr. Jones' £10,000 ownership state
- Start – Mr. Smith's £10,000 ownership state

There is a reasonably direct correspondence between the cash account movements and the £10,000 ownership state events. The correspondence with the car ownership events is distorted by the ledger using the cash valuation amount rather than the car (asset) directly for entries in the car account. This illustrates that the events give a more accurate picture that the accounting movements. However, a look at Figure 3 helps us to see why, within the confines of a paper and ink technology, the more accurate picture might not be practical.

Notice also the similarities between the events and the four entries described by (Manzoni 1534) in the extract quoted earlier. And that, like them, the events are explicitly linked to the proprietor. This new way of looking at the business situation resolves these two well-known inadequacies.

The ontological analysis does not take a particular participant's perspective. However, one can build an epistemology on top of this ontology that takes either Mr. Smith or Mr. Jones' perspective. This would leave us with their two ownership events – a picture much closer to Pacioli's.

**A core bookkeeping object – business transaction**

Traditionally the business transaction has the accounting movement as parts or aspects. It makes sense to regards all four ownership events as parts of the transaction – reconfirming that the relationship between a business transaction and the ownership events as mereological – whole-part. This cannot be all the transaction is. A key element of the transaction is the agreement of the parties, Mr. Smith and Mr. Jones. These agreement activities can be seen as temporal slices of the two parties. These elements of the transaction and the transaction itself can all be seen in Figure 3's space-time map.

**A core bookkeeping object – accounting entity**

This is a picture of a simple business transaction involving two people. There is a complication that shows up when one starts mapping the extensions of parties that are large organisations.

Consider a business transaction entered into by a division of a large company. The agreement activity is undertaken by someone in the sales department of the division. Yet the division is the party

responsible for the agreement. It appears that responsibility is inherited by the whole for the part's activities. A similar pattern appears if one asks whether the overall company is responsible for the division's agreements – the answer is yes[35]. This gives us a hierarchy of parties that are involved in the transaction through the activities of a single common part[36]. The traditional ledger cannot represent this situation as it implicitly assumes a single proprietor and a single counterparty.

This assumption of a single proprietor places other restrictions on what the ledger can represent. For example, it cannot represent business transactions between two parts of the proprietor in the proprietor's ledger. When one division enters into a transaction with another, the proprietor is not a party to this, so it cannot be represented in its ledger.

These two restrictions can be explained in terms of the ledger being an epistemology that shows the perspective of the proprietor. From this perspective, only the proprietor's involvement in a transaction is relevant, the rest of the hierarchy of parties is not – similarly transactions that do not involve the proprietor are also not relevant. Within the constraints of paper and ink technology it may make practical sense to settle on a single perspective – with more modern computer technology, it seems an unnecessary constraint.

**A core bookkeeping object – day**

The third foundational business object on our list is day. Traditionally days are periods of time and the relationship with a business transaction is determined by the day upon which the business transaction was made. An ontological analysis of day, requires a general ontological analysis of time periods – this can be found in Ch. 17 – Re-engineering Time of (Partridge 1996). Here a time period is a time slice of the whole universe – for the relevant time period. Days are time slices that start at the beginning of the day and finish at the end of the day. This gives us an extensional explanation of the relationship between days and business transactions – it is mereological. Business transactions are part of the day. One can see this in Figure 3 – where the day object '1st April 2001' is shown.

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[35] Assuming the division is not a subsidiary, but a part of the overall company.

[36] Partridge (2002f) *What is a customer?* notes how every element of this hierarchy is a customer of the counterparty to the transaction.

There is an element of epistemic practicality in this. It is an epistemic decision that the system will only *know* the day that the transaction took place rather than the exact time period in which the business transaction actually took place. There is, in principle, no reason why one should not choose a different standard period, and, for example, record the hour or the minute within which the business transaction is made. This may not have been practical with paper and ink technology but has surely become feasible with modern technology. A more modern epistemology of business transactions would need to be able to account for knowing when the transaction took place with finer granularity. In practice, many enterprise systems do this – recording the time of the transaction. The current constrained accounting systems only 'see' the day.

**A re-arranged view of things**

It is not possible to illustrate here in this short space how the process leads to more general, simpler patterns but, the brief examples given here should show how taking an ontological view gives us a different, more precise, view of the familiar foundational objects. Accounting movements become ownership events, which are components of business transactions, which are, in turn, parts of days. A single proprietor is shown to be merely one aspect of the transaction – which can involve a whole hierarchy of organisations. It also shows how the process can naturally resolve well-known inadequacies within a more precise framework.

**The way forward**

This is only a glimpse of what the new scheme may look like. It is probably only a first step towards the final scheme. Some relevant work is documented elsewhere. (Partridge 2002d) has a reasonable analysis of the mereology of organisations. (Partridge 2002f) has an example of how this may be applied.

The notion of business transaction requires more work. Its intentional nature needs more of an explanation, especially an account of why it is revisable. Also the full variety of patterns of business transactions needs to be accommodated.

The notion of asset also requires more work. The example simplified matters by considering the underlying physical object. The business transaction is actually in the property rights – and this needs to be analysed further.

The notion of valuation requires more work. This will need a general account of modality – as valuations typically consider what something would be worth if one sold it.

## Summary

When a substantial undertaking is proposed, it is important that people understand what the result is going to be, why this is needed and how it is going to be arrived at. This paper has aimed at making these points clearer.

It has briefly reviewed why the emergence of computing technology has created a need for a radical shift in the foundations and framework of accounting's conceptual scheme. It has recommended ontological analysis as a process for undertaking an early stage in this process – the shift of the foundations. It has given a brief explanation of what ontology in general is and what this process is in particular. It has then used the basic elements of bookkeeping to illustrate how ontological analysis works and how it leads to radical different views of well-known phenomena. Together these give a good basis for understanding the nature of the undertaking.

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