Thoroughly Modern Accounting: Shifting to a De Re Conceptual Pattern for Debits and Credits

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Abstract. Double entry bookkeeping lies at the core of modern accounting. It is shaped by a fundamental conceptual pattern; a design decision that was popularised by Pacioli some 500 years ago and subsequently institutionalised into accounting practice and systems. Debits and credits are core components of this conceptual pattern. This paper suggests that a different conceptual pattern, one that does not have debits and credits as its components, may be more suited to some modern accounting information systems. It makes the case by looking at two conceptual design choices that permeate the Pacioli pattern; de se and directional terms - leading to a de se directional conceptual pattern. It suggests alternative design choices - de re and non-directional terms, leading to a de re non-directional conceptual pattern - have some advantages in modern complex, computer-based, business environments.

Keywords: De se · De re · Directional terms · Debits and credits
Accounting information systems

Miss Dorothy Brown: You're a modern! Millie Dillmount: Thoroughly!

Thoroughly Modern Millie (1967)

1 Introduction

Double entry bookkeeping is at the core of modern accounting practice. The system was devised by the merchants of Venice and popularised by Pacioli in a book printed in 1494. Its basic principles have largely remained intact over the last five centuries despite business environments becoming significantly more complex and, more

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recently, the emergence of computing technology. This is testimony to the good design of Pacioli's conceptual pattern (though cynics may say the accounting community's inherent traditionalism also played a part). However, as noted elsewhere (for example Mattessich [1] and McCarthy [2]) the roots in a manual paper-based system (and a simpler business environment) may also indicate that these structures are ripe for change. The question then arises; what kind of change?

This research paper has two goals. Firstly, to provide an analysis of one of the core conceptual patterns that underlie modern accounting information systems. Put differently, we look at two conceptual design choices that permeate Pacioli's approach - leading to what we call a de se directional conceptual pattern. This pattern emerges from the decision to manage financial information from an owner/proprietor's perspective and it permeates the conceptual model. At its heart is the notion of debits and credits. We reflect upon the pressures that would motivate these choices in Pacioli's time.

Secondly, we then ask whether this de se directional pattern still makes sense in the context of modern computing technology and accounting requirements of transnational corporations. We do this by contrasting it with a different conceptual pattern - what we call a de re non-directional conceptual pattern. This pattern is an alternative 'view from nowhere' from which particular de se perspectives and their debits and credits can be generated. We speculate on why this pattern might be better for some modern accounting requirements.

We start by describing, in Sect. 2, the approach that was followed for identifying the conceptual pattern and the design choices that underlie them. In Sect. 3, we show how this conceptual pattern shapes the conceptual model of accounting information systems. In Sect. 4 we review the issues the pattern gives rise to and then in Sects. 5 and 6 look at the structures that materialise from the alternate choices. Finally, the paper ends with a conclusion and some future research directions.

2 Background: Two Related Conceptual Patterns

As noted above, while it seems likely, if not obvious, that Pacioli's approach is ripe for change, it is far from obvious or easy to work out how it should change. We spotted the opportunity for change described here in our legacy system re-engineering work [3]. This has involved the mining of ontologies from a number of accounting and ERP systems. In every case, one aspect of the resulting ontology – a view from nowhere – has struck us as odd. This was that the mining of the debit and credit transactions revealed a picture with no debits and credits [4]. More recently, when implementing the mined ontology, we have noticed that in the implementation we have needed to mark the owner/proprietor in the system and generate debits and credits (essentially adding back perspectival details that the original ontology mining removed). Reflection upon these and some initial research led us to recognise that a well-researched topic in philosophy – the de se – de re distinction [5] – underlay these two phenomena. We reported this in [6] which investigated the general topic of de se and de re. However, in the case of accounting, and specifically debits and credits, we recognised that de se is only part of the picture, that there was another philosophical topic in play – directional attributes [7, 8]. In this paper we give the more detailed picture that takes account of

both topics. We focus on the specific case of debits and credits in accounting and two design choices that have surfaced in our legacy reengineering work.

2.1 Directional Terms

Identity plays a big, often unrecognised, role in formalisation [9]; one particular concern is that different views on identity lead to different conceptual models. The conceptual design choice we are interested in here is the decision to use what we call directional terms and the temptation to simply reify these as objects.

This topic has ancient roots. It appears in Aristotle [7] where he discusses the road from Thebes to Athens and contrasts it with the road from Athens to Thebes; where the first is uphill and the second downhill. It seems inconsistent to say that one road is both uphill and downhill, but equally it seems odd to say there are two roads. More than that, as shown in Fig. 1, there are perfectly reasonable ways of showing the gradient of the road without any commitment to uphill and downhill objects.

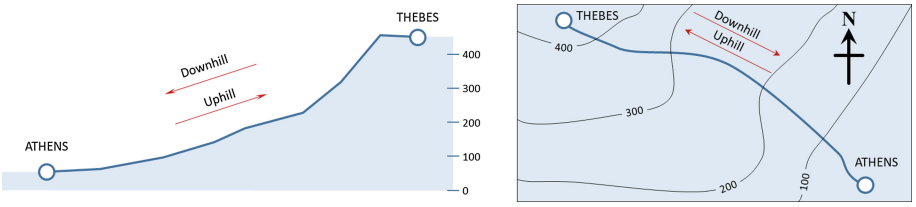

Fig. 1. The road between Athens and Thebes.

Wiggins [8] considers this conundrum. He suggests "that either 'road' means an actual feature of the landscape, in which case 'uphill' collects a term giving the direction and there is a simple relational predicate true of that road, or it means 'journey by road', in which case there is no identity." As Wiggins notes, in the first case, the work that uphill and downhill are doing is not picking out different objects, but building on a bundling together of the road with a direction - making the neutral 'road between Athens and Thebes' into the directional 'road from Athens to Thebes'. This 'directional term' can then be qualified as 'uphill'.

We explain below how much of modern accounting, in particular talk of debits and credits, uses these kinds of directional terms and so provides an opportunity to unbundle the term into the underlying objects.

2.2 De Se (And De Re)

Another important conceptual design choice is when and how to use the de se (Latin 'of oneself') [5]. In ordinary language, whenever we use indexicals like 'me', 'myself' and 'I' we are making a de se formalisation choice - where the self plays the role of the deitic centre (From Greek *deixis*, lit. 'display, demonstration, or reference', meaning point of reference in contemporary linguistics). Technically a de se statement can be translated into a neutral one - called de re (Latin 'of the thing') - by replacing the

indexical with a proper noun - what could be called de-re-ifying. So, John saying 'I am left-handed', can be translated into 'John is left-handed'; though it would be odd, but not incorrect, for John to describe himself in the third person. Directional terms and the de se can overlap, in that de se phrases can provide the direction needed for directional term. The traditional example is, 'I am walking uphill' where the deictic centre provides the context for the directional term.

In information systems, the de se appears in guises other than these natural language indexicals, which can make it difficult to identify. To help us with our analysis of the underlying formalisation choices, we can draw on an observation from philosophy and linguistics, (where a good understanding of what differentiates the de se (indexical) and de re (non-indexical) has been developed). A characteristic of pure (de se) indexical utterances is that the reference (and truth) of a sentence can shift from use to use. For instance, if John and Mary both utter the sentence 'I am left-handed', the two utterances refer to different things; namely that (in de re non-indexical terms) 'Mary is left-handed' and 'John is left-handed' respectively. And there is no (logical) inconsistency in one of the utterances being true and the other false. This does not happen with non-indexical de re uses. So, for example, the reference (and truth) of the sentence 'Mary is left-handed' does not change whoever, wherever and whenever it is uttered - each utterance has exactly the same content.

2.3 Accounting Information Systems Implications

Accounting information systems often have de se directional reporting requirements. For example, companies' major financial accounting reports are de se directional; the balance sheet and profit and loss statements report the balances from the 'owner's perspective'. The simplest prima facie design for this reporting is to store the information in de se form and then report it directly (let's call this 'de se storage and reporting'). The alternative design, storing the information in de re form and then querying the de se information (let's call this 'de re storage and de se querying') seems to be unnecessary extra work. Furthermore, the de se storage will appear more parsimonious than the de re as it has no need to make the deitic centre explicit (though one could counter-argue that the implicit deitic centre is not transparent).

However, this assumes that only a single de se perspective is required. If multiple de se reporting over the same de re information is required, then the situation is different. Firstly, it makes more sense to input the information once (whether in de re or de se form) and then calculate the required reporting/presentation forms. Given this, adopting a 'de se storage and reporting' approach here would need multiple processing on input and lead to multiple de se storage silos each with the same information stored in different de se formats. This will open the door to the data anomalies and corruption associated with data redundancy. Here a 'de re storage and de se querying' strategy becomes more attractive. The master de re information is stored only once and the de se queries generated as required. It becomes even more attractive if the de se reporting requirements are volatile, in the sense of new de se perspectives emerging and old de se perspectives retiring (for example, companies joining and leaving a group).

3 De Se and Directional Terms in Accounting

In this section, we look at de se directional conceptual pattern in the double entry accounting conceptual model.

3.1 Pacioli Introduces Modern Accounting

Fra Luca Bartolomeo de Pacioli is known as the father of modern accounting and bookkeeping because he was the first person to publish a detailed description of double-entry bookkeeping that is the foundation for modern accounting. He described this as the method used by Venetian merchants in the final chapter (Particularis de computis et scripturis - About accounts and other writings) of his mathematical text-book Summa de arithmetica, geometria. Proportioni et proportionalita [10] published in Venice in 1494. It was published soon after the introduction of moveable type printing, making it significantly more accessible, and this undoubtedly contributed towards its popularity.

Pacioli's system starts with an inventory and then has a system of internal controls containing three books which has a well-defined process to update the records in a specific order. Whenever there is a transaction, the system starts with a description of the complete transaction in the Day Book or Memorandum (from, as we shall discuss later, the perspective of the owner). From this debit and credit postings for the day are extracted and recorded in the Journal. Finally, these postings are re-recorded under the appropriate account in the Ledger [10].

3.2 Pen and Paper – Designing for Presentation

With pen and paper technology, the storage is external (on paper) but the processing is human. Where the final presentation data is viewed many times, it makes sense to have a system where humans process the data into the final presentation format and then store it (on paper) in that format – then the paper storage can be read directly. This is rather than store the data in its original format and process it into the presentation format each time it is required. Pacioli's design for his process recognizes this. Figure 2 represents the Pacioli process - Pacioli's 'Summa Mathematica' is included in the figure, as it acts as a kind of conceptual model for the manual process.

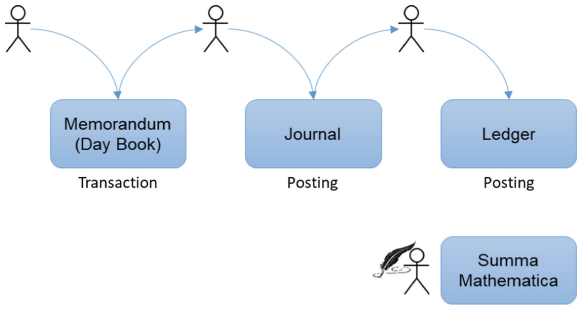

Fig. 2. Pen and paper based accounting process.

This process-once-before-storage approach makes even more sense when one considers the practical concerns with the errors that could arise in the manual recording process. Pacioli takes advantage of the process' algorithmic nature to provide step by step instructions as well as internal controls to mitigate this. From the very beginning, he identifies these internal controls as key to successful bookkeeping [10] and describes a number of them in detail (for example, numbering the pages of the journal to make it easy to identify when a page has been removed and double underlining the journal side entry to mark the two entries in the ledger). There is a significant amount of algorithmic manual processing to keep the entire dataset consistent - with checks to ensure the algorithms were followed correctly.

If the data was not stored on paper in the final presentation format, then this burdensome processing would have to be done multiple times, each time the data was reported. So the final presentation format (which is de se directional) dictates the structure of the paper storage. As we discuss later, these information management concerns were formative for the de se directional conceptual pattern in the design of the system.

3.3 Automation - The Modern Implementation of Pacioli

From our modern perspective, the transcription from Journal to Ledger is just an automatable sort, where the postings are arranged firstly by date (in the Journal) and then by date within account (in the Ledger). And the transcription from Day Book to Journal as an automatable query over the transaction details. So, to our modern eyes the process reveals itself as algorithmic and so automatable. One that we can break down further into a kind of data model for the items being processed - see Fig. 3 - where the leg is the implicit asset (economic resource) that is being posted against.

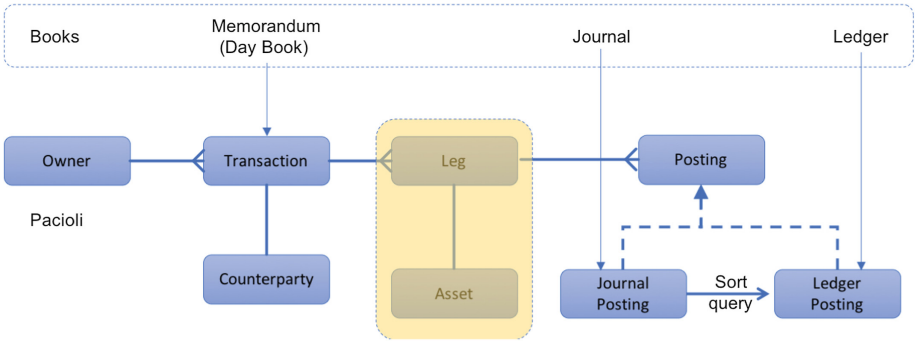

Fig. 3. Breakdown of a typical transaction.

One of the advantages of computing over pen and paper technology is that it enables automated processing inside the computer system rather than manual processing by humans – and the cost of repeating a computer process is insignificant when compared with the cost of repeating the equivalent manual human process. So there is

no longer a pressure to store data in the form it will be presented – the computer can reshape the stored data into the format needed for presentation. This enables information architectures where the form of the information that is entered or presented is different from that which is stored - as shown in Fig. 4, compare this with the equivalent Fig. 2 for pen and paper technology.

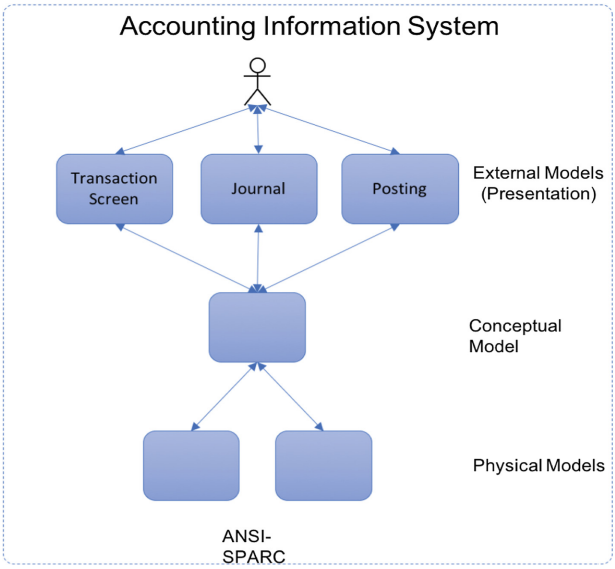

Fig. 4. Accounting information system accounting process

More sophisticated data architectures, such as the ANSI-SPARC 3-layer model [11] - divorces the design of the information system from the particular constraints of a physical implementation technology by introducing a conceptual layer. Each new layer raises questions about how its information structures should be formalized: whether the conceptual design choices and corresponding conceptual model developed for flat, sequential pen and paper technology architectures should carry over to the new technologies. Later on, we look at how our two selected conceptual design choices have been and should be architected in the conceptual layer.

The obvious opportunities for automation are the manual processes prescribed by the double entry system and these have been exploited by modern accounting systems. Typically, users only enter the transaction once, into the computer equivalent of the Day Book. Then the system algorithmically generates the debit and credit postings and posts them into the journal and ledger accordingly. The question we explore here through our investigation of the conceptual patterns in accounting is whether there are less obvious opportunities for a layered implementation of information architecture yet to be exploited.

3.4 Examples of De Se Directional Terms

In this section, we make clear through examples that Pacioli's accounting information system (and so also modern systems) have consistently made a choice for a de se directional conceptual pattern based upon a single owner's perspective. The examples show how this choice extends from the owner, through transactions to debits and credits.

Transaction Party - Counterparty Distinction

In Pacioli's section on day book entries and examples, he writes this description of a transaction: "Purchased from Phillip Ruffon - white silks at 12 ducats each". Presumably, Phillip Ruffon would write in his books: "Sold to Fra Luca Pacioli - white silks at 12 ducats each". This illustrates the de se directional tradition, still used today, of recording the parties to a transaction; where the owner of the books is the deitic centre and is assumed to be one party to the transaction, then only the other party, the counterparty needs to be explicitly recorded. Clearly, this is de se directional: one can only be a counterparty relative to an owner: it would be more accurate to call them owner counterparties. There are no de re counterparties; in the de re 'perspective', transactions have parties, simpliciter: no party has a priority. This situation is shown in Fig. 5.

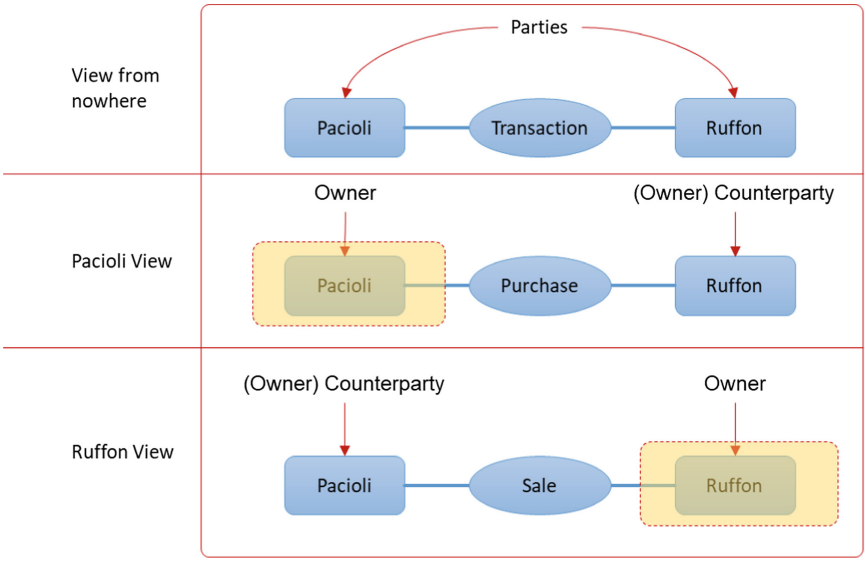

Fig. 5. Parties - viewed in de se as party and counterparty.

The two example descriptions also show how the introduction of a silent owner with a counterparty has a knock-on effect, in that it naturally leads to the use of owner-relative terms such as 'purchase' and 'sale' - which reflect the direction of flow of goods to the owner. These terms make no sense in the de re 'perspective'.

Owner of the Books
The owner is clearly a silent partner in the transaction recorded in the day book. But for this system to work, it needs to be clear who this silent owner is. Pacioli consistently says that his 'internal control system' is for a businessman - this is the silent owner of all the books. This greatly simplifies identifying the owner, it is the same entity for all the transactions in the set of books. In Pacioli's day, the owner's name might be written on the cover of the books. In modern systems, it may be recorded in a system configuration file. However, as we discuss later, this simplification comes at a cost - as the owner has to be a party to all the transactions and they all need to be accounted for from its perspective.

Directional De Se Debits and Credits
The owner's de se directional formalization extends to debits and credits. Typically, a debit from one party's perspective is a credit from the other party's perspective. To return to the original Pacioli example; where he purchased 20 white silks at 12 ducats each - 240 ducats in total. In the Journal he will credit Cash for this payment to Phillip Ruffon. In his counterparty's (Phillip Ruffon) books, this entry would appear in his journal as a debit to Cash for the receipt from Luca Pacioli. This is slightly clearer in Pacioli's original language where he uses the terms 'to' and 'from' (in Italian 'per' and 'a') rather than debit and credit.

4 De Se Accounting Issues

As we noted earlier, the Pacioli conceptual pattern assumes a single de se directional perspective across all the books. So, where a requirement for accounting for the same transactions across multiple perspectives/parties arises within the books, we would expect the current system of accounting to begin to show signs of strain with work-arounds that result in unnecessary complications. Where one party has a number of other parties as components, the de se requirements are even more convoluted as in some sense there is a requirement to share books. A common example of this, which we explore below, is the consolidation required for inter-company accounting. This requirement was not common in Pacioli's time, because the kind of company ownership structures we have today did not exist then. However, today with large multinational firms with operations around the globe and disparate local legal and tax obligations, this requirement is common. A similar case occurs in correspondent banking where effectively banks share accounts (this is explored in [6]). More generally, where there is a need for a cross-organisational viewpoint (for example, supply chain management – see [12]) or for interoperability between organisational units the single de se perspective becomes unwieldy.

Today, global value chains account for 80% of global trade[1]. A large proportion of this is intra-firm trade (i.e. international flows of goods and services between parent companies and their affiliates or among these affiliates). Part of this growth in recent times is through consolidation of larger multinationals through acquisitions.

[1] http://unctad.org/en/pages/PressRelease.aspx?OriginalVersionID=113.

These consolidations result in heterogeneous accounting systems and charts of accounts being amalgamated using 'band-aid tactics' with the result that the data does not satisfy the requirements of all the primary stakeholders, namely accounting, tax and treasury [13].

The current standards for inter-company accounting, build on the same de se foundations and therefore yield some interesting complications. This is because there is a requirement to take the following perspectives over the transactions:

1. Parent company only de se and directional. This is for accounting for the parent company as a legal entity that transacts with other legal entities (including its subsidiaries).
2. Company group including subsidiaries de se. This is for accounting and financial reporting of the group as a single entity (treating all transactions within the group as internal).
3. Subsidiaries de se. This is for accounting for the subsidiary as an independent legal entity that transacts with other legal entities (including the parent company and other subsidiaries of the parent company).

Figure 6 shows the various directions the transactions can flow in this kind of setting [14].

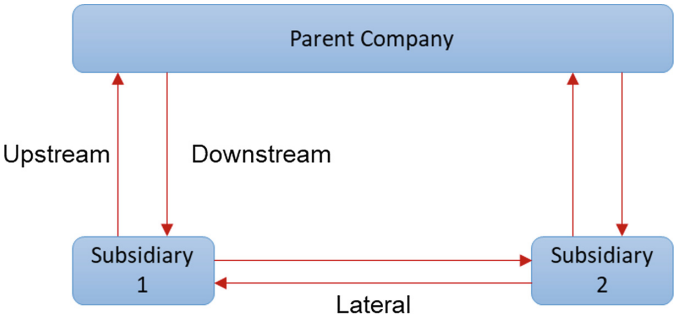

Fig. 6. Directions inter-company accounting.

Therefore, when a downstream transaction is initiated (from parent to subsidiary), each party records the transaction from its perspective as if it is transacting with a third party. Later when the parent company accounts have to be consolidated, the parent company's books have to view the same transactions as if they were internal and therefore have a net-zero effect on the group's assets and liabilities. There is no simple way to reconcile the individual de se transactions into a single parent de se transaction. Calculations have to be carried out outside the books to work out the net changes required to 'hide' the internal transaction. All this overhead is there because there is no single de re, non-directional account of the transaction and each de se account is incompatible with the other.

Worked example: in the case where a parent pays £600 to a subsidiary, the following postings will be made:

- Parent's books credit £600
- Subsidiary's books debit £600
- later parent has to post another debit £600 again into its books to net out the transaction (as if it never happened).

In the above, there is only one movement, but there are three postings, because it is not possible to record the movement in an agent neutral representation. The above example is a very simple transaction leg posting, the actual process of elimination is typically quite intricate, because the transaction's impact has to be externally calculated for each affected account of the parent/subsidiary books. These elimination amounts are then posted into the relevant ledger accounts in order to show either that the 'transaction never happened' (where all legs of the transaction are within the Parent company's owned entity structure) or that the internal changes did not happen but the external component of the transaction did (where there is a third party involved). This process does not stop at the initial transaction but needs to be continued every time any loss or gain needs to be booked. For example, when an asset is sold downstream, depreciation has to be calculated from the subsidiary's perspective using the subsidiary's purchase price. However, from the parent company perspective, because the transaction 'never happened', an adjustment has to be posted in the parent company's depreciation account to account for the Parent company's purchase price.

The current design for managing this intercompany accounting is based on a large number of off-book calculations that have to be performed to establish the values of adjustment postings required. This is additional work that is outside of the standard practices of entity accounting and has to be standardised separately and is implemented differently in different organisations. The manual nature and complexity of the processing introduces risks of mistakes and inconsistencies in the accounting data. It also becomes very difficult to account for all the regulatory and financial requirements imposed by the tax and treasury departments based on their specific perspectives over the financial data.

5 Related Research

This review of the conceptual patterns is raising questions about the foundations of accounting's information architecture. People have been raising these kinds of questions for a while. In the 1960s there was an interest in developing axiomatic foundations for accounting. Mattessich in [15] developed a set theoretical axiomatisation of accounting where full chart of accounts was structured as entries stored in a matrix. More recently the REA approach [2] has aimed at rethinking accounting conceptual models, explicitly suggesting this is driven by the introduction of computing technology. While both these projects challenge some of the elements of the current traditional architecture, neither has made any real attempt to shift away from Pacioli's de se directional formalisation choices apart from changing names; for example, talking of inflows and outflows rather than debits and credits. We look at REA's approach briefly below.

More interestingly, one can see the de se directional approach coming unstuck when faced with the practical challenges of implementing interoperability and reuse. We show this happening in the FIX messaging standard[2] and Universal Enterprise Data Models [16] which both drop the de se structure of owner/counterparty for a simple de re party structure. However, none of these try to unravel the choices inherent in Pacioli's debits and credits. So finally, we briefly outline how this can be done, and show what a de re version of these would look like.

Accounting Theory - The REA Framework

REA [2] has the goal of modelling accounting entities semantically to support data integration at the enterprise level - and sees the Pacioli information structures as irrelevant to this purpose, saying: "The primary contention of this paper is that the semantic modelling of accounting object systems should not include elements of double-entry bookkeeping such as debits, credits and accounts. As noted previously by both Everest and Weber [17] and McCarthy [18], these elements are artefacts associated with journals and ledgers (that is they are simply mechanisms for manually storing and transmitting data). As such, they are not essential aspects of an accounting system." REA, in our view, correctly recognises that the Pacioli structure as driven by the manual demands inherent in pen and paper technology and identifies the opportunity for shifting to a new structure to exploit computing technology. It explicitly discusses how computing technology enables the ANSI-SPARC separation of views. It furthermore recognises that the economic events happen to economic resources (assets). However, despite its stated rejection of the Pacioli information structures, it continues to subscribe to the fundamental de se directional view inherent in its foundations. Prima facie its talk of 'inflow' and 'outflow' as well as 'increments' and 'decrements' are directional. And further inspection shows that it adopts an owner-counterparty view - focusing on the view from a single entity. Hruby et al. [19] makes this point (in Section 1.2.1), where he clarifies that "(t)he terms decrement and increment are relative to the model viewpoint: they depend upon the economic agent which is in the focus of the model" and in the context of his example, "if we modelled the same process from the perspective of the Customer, the transfer of the pizza would be an increment (would be called Purchase) …". The pattern of the transaction shifting from a sale to a purchase as the perspective changes we described earlier reappears here.

FIX Messages

The Financial Information eXchange protocol is used for real-time exchange of information between organisations in the international securities transactions and markets. It provides us with an example of how the practical requirements of interoperability lead to a de re view of parties. The protocol includes a <Parties> component that is used to identify the transacting parties or any other parties that have a role (broker, clearing firm, exchange, settlement bank) in the transaction. All parties are handled in the same format, and they are allowed to have multiple roles in different transactions. In this complex ecosystem, with a high volume of financial instrument trading, the de re party structure offers a fast, reliable and efficient way for different

[2] FIX - www.fixtrading.org.

organisations to exchange transaction data. It is not clear how this could be done in a simple de se way as there is no obvious candidate for the owner - any de se solution would lead to each of the parties having to create data from their individual perspectives, in other words, a multiple de se architecture.

Universal Data Models

Silverston has produced a series of volumes (including [16]) documenting practitioners' experiences in building what he calls a universal data model for all enterprises. This provides a good insight into data modelling. As with FIX, this clearly uses a de re party pattern, there is no evidence of a de se directional owner-counterparty pattern. Indeed, given the overall structure of the model it is difficult to see how a single privileged owner party could be identified. FIX and the universal data model examples show that, at least at the party level, modern computing data architectures are often not suited to a de se architecture.

6 Outline of a Universal (Pure) De Re System

However, the de se aspect of debits and credits is more intransigent; remaining in both accounting theory, data modelling practice and implemented systems. We use ontological analysis to help unravel the historical de se choices and reveal the underlying de re. We do this using the BORO [3] four-dimensional top ontology, which reveals that assets (economic resources) have stages where they are owned by parties. This is shown for the cash element of an exchange in the space-time map in Fig. 7.

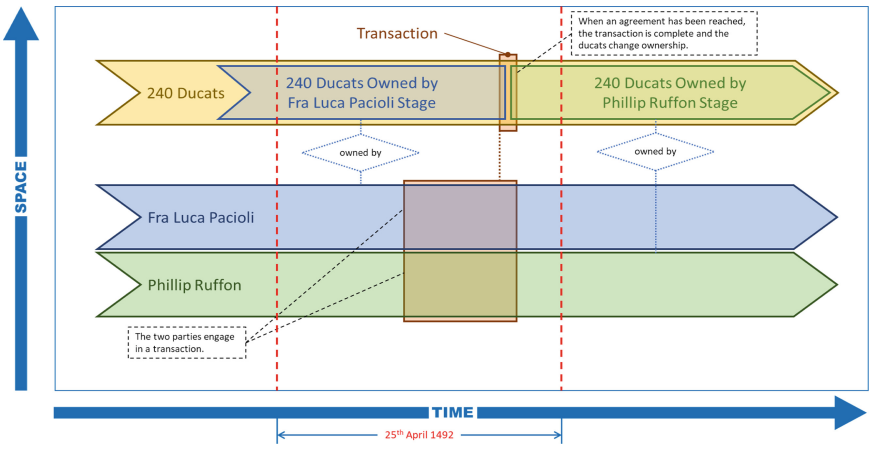

Fig. 7. 240 ducats state change event space-time map.

For a period, a state of the 240 ducats is owned by Fra Luca Pacioli, then the subsequent state is owned by Phillip Ruffon. The boundaries of these states mark changes in ownership. These states and their state boundaries fit into a wider de re system from which a variety of de se reports, with different owners (deitic centres) can be generated - illustrated in Fig. 8.

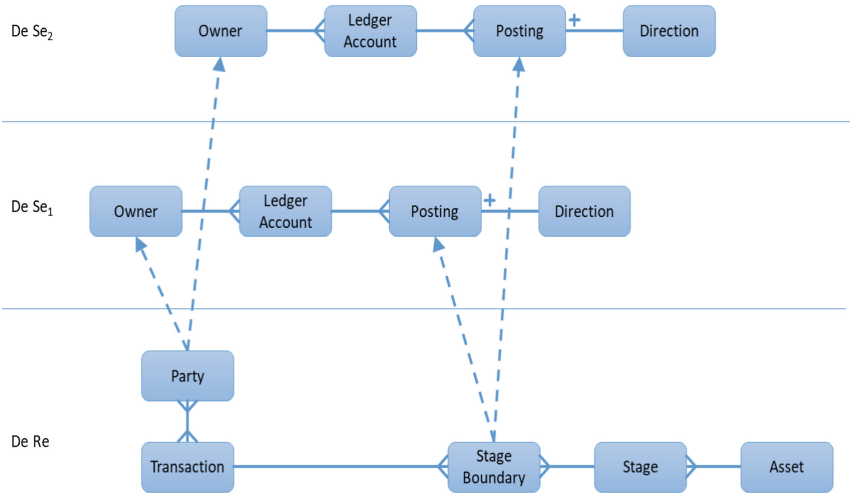

Fig. 8. Transaction viewed in de se/directional terms.

7 Conclusion

We introduced two conceptual design choices and used these to clearly expose how a de se directional choice permeates the whole of Pacioli's accounting conceptual model. We show how this choice stretches from the owner's books, through owner/counterparty transactions to de se directional debits and credits. We recognised that Pacioli's conceptual model was well suited to his contemporary requirements but also marshalled the arguments for change. Suggesting that the evolution of more complex business structures and the emergence of computing technology has changed the landscape to such an extent that there is an opportunity for improvement. We then outlined, using the four-dimensional BORO foundational ontology, a de re non-directional conceptual pattern to replace debits and credits and how this would fit into a complete de re non-directional conceptual model.

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