Core Semantics of Double-entry Bookkeeping

An interpretation of the Venetian Method of double-entry bookkeeping in machine readable form, a logical theory describing double-entry bookkeeping model

By

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"The purpose of what a system is what it does." Stafford Beer

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1. Introduction

The purpose of this document is to provide an interpretation of the core aspects, the essence, of the well understood and de facto standard double-entry bookkeeping model referred to as the *Venetian Method*[1].

There are plenty of human readable descriptions of double-entry bookkeeping model. David Ellerman provides on description in an article for *Mathematics Magazine*, *The Mathematics of Double Entry Bookkeeping*[2].

1.1. Bookkeeping versus Accounting

This document focuses on bookkeeping, not accounting. There is a difference between bookkeeping and accounting.

People often use the terms "bookkeeping" and "accounting" interchangeably. But bookkeeping and accounting are two different things. Here are definitions of both:

- **Bookkeeping** is a mechanical process of recording transactions. Bookkeeping is an action; it is a record keeping process.
- **Accounting** is about determining what constitutes the transactions that are then recorded per the bookkeeping process. Accounting is the language used by bookkeeping. Accounting is a communications tool. Accounting is a classification system.

Bookkeeping history is explained in the book *Double Entry: How the Merchants of Venice Created Modern Finance*[3] by Jane Gleeson-White. A search on "difference between bookkeeping and accounting" will provide you on additional details. Basically, bookkeeping relates to transactions, journals, ledgers, trial balances, chart of accounts and the mechanical process and details involved with recording transactions. Accounting relates to coming up with a proper chart of accounts, classifying transactions, converting the trial balance into a set of financial statements and getting the accounting details right.

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[1] Amazon.com, Jane Gleeson-White, D*ouble Entry: How the Merchants of Venice Created Modern Finance*, https://www.amazon.com/Double-Entry-Merchants-Created-Finance/dp/0393346595

[2] Mathematics Magazine, David P. Ellerman, *The Mathematics of Double Entry Bookkeeping*, https://www.ellerman.org/wp-content/uploads/2012/12/DEB-Math-Mag.CV .pdf

[3] Amazon.com, Jane Gleeson-White, *Double Entry: How the Merchants of Venice Created Modern Finance*, https://www.amazon.com/gp/product/B007Q6XKA8/

Note that triple entry accounting[4] or triple entry bookkeeping is not discussed in this document. However, part of the reason for this document is to help make triple entry bookkeeping more of a possibility.

For more information, please refer to the *Essence of Accounting*[5].

1.2. Mathematical Model

Ellerman points out that double-entry bookkeeping is based on well-known mathematics construction from undergraduate algebra. But Ellerman laments, "Mathematics and accounting truly seem to live in disjoint universes with no trespassing between them."

But computers work per the rules of logic and mathematics. Understanding the rules of logic and mathematics can help enhance your digital proficiency.

1.3. Controlled Vocabulary

A controlled vocabulary dictates the particular meaning of each term in an area of knowledge or system of interest. The controlled vocabulary could allow synonyms; but should not have homonym or ambiguity. A controlled vocabulary employs terms unique to an area of knowledge similar to the notations of mathematics and music. A controlled vocabulary is a subset of natural language, used with a restricted grammar that reduces, preferably eliminates, all ambiguity and complexity.

Terms are defined by describing a specific set of features and differentiating a term from every other term unambiguously.

1.4. Digital Proficiency

There is a difference between how "real space" and "cyberspace" work and it is important that accountants and others to develop the digital proficiency[6] to help them thrive in the digital world we live in.

Part of this paradigm shift is creating the tools that enable us to survive and thrive in this new digital world. This articulation of the core semantics of double-entry bookkeeping is one of those tools.

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[4] YouTube.com, *Triple Entry Accounting*, https://youtu.be/wWXy7wUDEoQ?si=JBxdThhsG7aHwrpw

[5] Charles Hoffman, CPA, *Essence of Accounting*, https://xbrlsite.azurewebsites.net/2020/Library/EssenceOfAccounting.pdf

[6] *Digital Proficiency*, https://digitalfinancialreporting.blogspot.com/2024/05/digital-proficiency.html

1.5. Happy Path

The objective of this document is to stay on the "happy path" and not get distracted by the rush to detail which would turn this simple project into a significantly more time-consuming endeavor.

I am explicitly avoiding the rush to detail and focusing on the core which is necessary for everyone. It may not be sufficient for specific organizations, but I can say that every organization needs these necessary pieces which is the focus of this document.

1.6. Focus on Core Capabilities

The semantics described focus on core, fundamental capabilities. The core, fundamental capabilities can be expanded and enhanced. For example, the notion of the "general ledger" is core. Subledgers (a.k.a. special ledgers, subsidiary ledgers) is simply a specialization of a general ledger. The core semantics does not discuss subledgers, but it does contemplate their existence.

1.7. Acknowledgements

This work builds on work by Bill McCarthy who described *Resources, Events, Agents* (REA)[7], Willi Brammertz who is behind the creation of *ACTUS* (Algorithmic Contract Types Unified Standards)[8], Peter Frampton's work summarized in *The Joy of Accounting*[9], Andrew Noble who is behind the creation of an open-source RDF based accounting engine[10], and XBRL International's work related to *XBRL Global Ledger*[11].

[7] Wikipedia, *Resources, Events, Agents*, https://en.wikipedia.org/wiki/Resources,_Events,_Agents

[8] ACTUS.ORG, https://www.actusfrf.org/methodology

[9] Google Books, *Joy of Accounting*, https://www.google.com/books/edition/The_Joy_of_Accounting/t_rbzQEACAAJ

[10] Open Source RDF Accounting Engine, https://digitalfinancialreporting.blogspot.com/2024/03/open-source-rdf-accounting-engine.html

[11] XBRL International, *XBRL Global Ledger*, https://www.xbrl.org/the-standard/what/global-ledger/

2. Narrative

In this section I will provide a precise, comprehensive, yet succinct narrative which explains the double-entry bookkeeping model.

It is sometimes the case that different terms are used in different ways which can be confusing to novices and experts alike. There is no specific magic in selecting one term over another and arguing about which term is the best misses to primary point. The point here is to provide one terms, define that term clearly, and use the terms consistently.

2.1. Journal

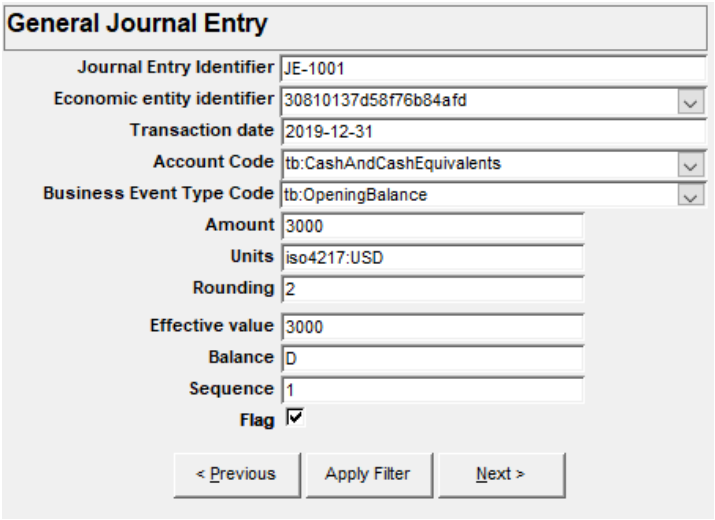
A journal is the original list of transactions in a bookkeeping system. A journal has entries.

2.2. Journal Entry

At a minimum, a journal entry provides the following information:

- Journal entry identifier of some sort.
- Economic entity to which a journal entry relates.
- Calendar date of the business event driving the journal entry.
- Account to which a journal entry amount is categorized.
- Amount of the entry.
- Currency of the amount.
- Indication as to whether the amount is a DEBIT or CREDIT.
- Event type which, similar to account, is used to categorize or group a journal entry representing a business event.
- Dimensional information which further distinguishes/categorizes a journal entry. (actual, budgeted, etc.)

Here is an example of a portion of a journal entry within a double-entry bookkeeping system which has implemented using Microsoft Access which I created:



Remember that different implements of double-entry bookkeeping can use different approaches to implementing a journal entry but the core logic conveyed by the journal entry should be exactly the same in every such implementation.

Further, note that all information is explicitly provided. Other additional information could be added to the core journal entry information, but none of the necessary information (i.e. the bullet points above) could really be removed.

2.3. Ledger

A ledger is a place where the information from journal entries is recorded. Once information is entered or "posted" to a ledger, that information can never be removed. If an error exists within a journal entry, to correct that error another journal entry is created and posted to the ledger to make the necessary adjustment to the ledger to correct for the mistake and to leave a trail of information.

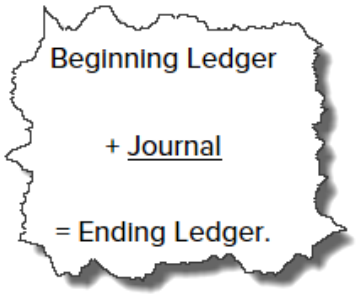
There are a number of different types of ledgers that accountants use. General ledgers, special ledgers, subsidiary ledgers, and other such names are used to refer to these ledgers. For example, a sales ledger is used to record sales transactions of an economic entity and a purchases ledger is used to record purchases of an economic entity.

Fundamentally, all the different types of ledgers provide all of the same core journal entry information.

2.4. Stocks and Flows

The relationship between journal entries and ledger balances can be understood using the notion of "stocks" and "flows". David Ellerman's

article, *The Math of Double-Entry Bookkeeping: Part II (vectors)*, explains the relationship between a ledger and a journal[12]. Specifically, this graphic from that article explains that relationship:



Ledgers contain the journal entry information which explains the flows which go through an account within the ledger and summarizes the stock which is a summary of the information about all the flows that have ever gone through an account. Other terms used for the relationship shown above are "roll forward" or "movements". All three of these terms basically explain the following equation:

"Beginning balance + Additions - Subtractions = Ending balance"

Balance sheet accounts are stocks. Roll forwards of the beginning and ending balances of balance sheet accounts are flows. The income statement is a flow of net income (loss). The cash flow statement is a roll forward of the net change in cash and cash equivalents. The statement of changes in equity is a roll forward of equity accounts.

Many transactions, events, circumstances, and other phenomenon are recorded as transactions in a journal, make their way to a ledger, and then end up in the primary financial statements or within disclosures which detail the line items of the primary financial statements. Much of this information is part of the two trees of information which make up the roll ups of "Assets" and "Liabilities and Equity".

The totals of each roll up, for "Assets" and for "Liabilities and Equity" must always be the same. This serves as a parity check to detect any error in the double-entry system.

[12] David Ellerman, *The Math of Double-Entry Bookkeeping: Part II (vectors)*, http://www.ellerman.org/the-math-of-double-entry-bookkeeping-part-ii-vectors/

2.5. Account

An account is effectively a grouping or classification mechanism for a ledger. If no accounts existed within a ledger, then all journal entries would go into (be posted to) one single big group. The notion of an account enables the grouping or categorization of journal entries.

Examples of accounts include:

- Petty cash
- General checking account at Wells Fargo
- Accounts receivable
- Finished goods inventory
- Sales
- Cost of sales
- Salaries
- Income taxes

Account names in a double-entry bookkeeping might be a number such as "1001" or "1001-55-0001". Basically, whether the account is identified using a human readable name or a number; that name or number simply is a token that is used to identify which account a journal entries goes into within a ledger.

2.6. Real versus Nominal Accounts

There are two types of accounts:

- **real** (or permanent) and
- **nominal** (or temporary).

Real account balances are never "closed" at the end of an accounting period; they begin each period with the ending balance of the prior period. Balance sheet accounts are real accounts.

Nominal account balances are "closed" at the end of an accounting period; they begin each period with a zero balance. Income statement accounts are nominal accounts.

2.7. Chart of Accounts

A chart of accounts is simply a listing of the account names that an economic entity uses to record transactions in its journals and ledgers. An economic entity tailors its chart of accounts to meet the specific unique needs of the economic entity.

Examples of account names that might be in a chart of accounts might be:

- Cash in bank
- Petty cash
- Other cash and cash equivalents
- Trade accounts receivable
- Finished goods inventory
- Work-in-progress inventory
- Raw materials inventory
- Land
- Buildings
- Equipment
- Trade accounts payable
- Long-term debt
- Retained earnings
- Sales revenue
- Depreciation and amortization
- Income tax expense

However, although an economic entity uses a unique chart of accounts internally, when information is reported that information is grouped following some financial reporting scheme.

2.8. Account Types

Every account has a type. Account types are used by accounting systems to process transactions and turn those transactions into a report. The five fundamental account types tend to be:

- Asset
- Liability
- Equity
- Revenue
- Expense

However, additional account types and hierarchies of account types can be leveraged to make generation of reports easier.

Specific accounts from a chart of accounts don't really tend to show up as line items of a financial report; rather it is the account types that tend to be used to represent report line items.

Part of the art of accounting is configuring and managing double-entry bookkeeping system metadata such that it provides the system user the information organized how they want to see it (internal reporting) or how they are required to report information (compliance reporting).

2.9. Business Events

Bookkeeping fundamentally captures information about the business events of an economic entity. Business event information is captured in the form of transactions that are entered into a double-entry bookkeeping system. The following is an example of a handful of business events that result in the creation of a transaction or transactions within a double-entry bookkeeping system:

- Investment of cash by an owner into a business
- Receipt of cash as a result of borrowing money from a bank or other financial institution
- Purchase of equipment by a business
- Purchase of inventory from a supplier on account
- Payment made to a supplier based on a recorded account payable
- Depreciation of equipment which had subsequently been acquired

Information about the business event type can be provided within a transaction and can be used to then classify information properly within the line items of a financial report.

2.10. Event Types

Business event information which are entered into a double-entry bookkeeping system have logical patterns or architypes or what amounts to a template for that type of business even type.

Event types tend to be the groupings within a roll forward which explains the changes that have occurred within a real or balance sheet account (a.k.a. roll forward grouping code).

The notion of a roll forward grouping code is informally implemented by Workday using the notion of a "work tag"[13]. Others implement this idea

[13] Workday, *Tales of the Cloud: The Story of Worktags*, https://blog.workday.com/en-us/2012/tales-of-the-cloud-the-story-of-worktags.html

using the notion of a "transaction verbs"[14]. The following is an example of event types summarized within a roll forward of a balance sheet account:

Concept [Aspect]	Period [Aspect]	
Receivables [Roll Forward]		
Receivables, Beginning Balance	2021-12-31	€ 1,231,338.47
Increase in Receivables from Sales on Account	2022-01-01 | 2022-12-31	2,604,048.36
Collection of Receivables	2022-01-01 | 2022-12-31	(1,799,918.56)
Additions to Allowance for Bad Debts	2022-01-01 | 2022-12-31	0.00
Bad Debts Written Off	2022-01-01 | 2022-12-31	0.00
Receivables, Ending Balance	2022-12-31	€ 2,035,468.27

2.11. Transactions

Information from a journal entry, generally two or more journal entries, forms a transaction. A transaction is a set of journal entries related to a business event which is then posted into a ledger.

2.12. Ledger Trial Balance

A ledger trial balance is effectively a summary (report) of transactions within a double-entry bookkeeping system. The trial balance can be the details of each transaction or a summary of transactions. Transactions could be filtered based on the fields available.

Here is a general ledger trial balance, detail for one account:

JournalEntryID	EconomicEntityIdentifier	TransactionPeriod	Account	EffectiveValue	Units	Rounding	Balance
JE-1001	30810137d58f76b84afd	2019-12-31	000-1100-00	3000	iso4217:USD	2	D
JE-1002	30810137d58f76b84afd	2020-01-01	000-1100-00	6000	iso4217:USD	2	D
JE-1003	30810137d58f76b84afd	2020-01-01	000-1100-00	-5000	iso4217:USD	2	C
JE-1006	30810137d58f76b84afd	2020-01-01	000-1100-00	3000	iso4217:USD	2	D
JE-1007	30810137d58f76b84afd	2020-01-01	000-1100-00	-2000	iso4217:USD	2	C
JE-1008	30810137d58f76b84afd	2020-01-01	000-1100-00	-1000	iso4217:USD	2	C

Here is a general ledger trial balance summarized by account:

[14] GitHub, Lodgeit Labs, https://github.com/lodgeit-labs/accounts-assessor

Concept [Aspect]	Period [Aspect] 2022-12-31
Accounts [Roll Up]	
000-1100-00 - BofA Checking	40,000
000-1105-00 - Payroll imprest account - B of A	15,000
000-1107-00 - Petty cash on hand	5,000
000-1200-00 - AR	230,000
000-1300-00 - Inventory on hand	300,000
000-1500-00 - Furniture and fixtures	210,000
000-2150-00 - AP	(90,000)
000-2300-00 - Note payable Bank of America	(75,000)
000-3200-00 - RE	(635,000)
Sum	$ 0

Here is a general ledger trial balance summarized by event type:

Concept [Aspect]	Period [Aspect] 2022-01-01 | 2022-12-31
Changes Summary [Roll Up]	
Proceeds from Collection of Receivables	€ 2,072,035.32
Proceeds from Investments by Owner	0.00
Payment for Distributions to Owner	0.00
Payment of Accounts Payable	(3,096,588.38)
Payment of Interest	0.00
Proceeds from Additional Long-term Borrowings	10,554.36
Payment for Reduction of Long-term Borrowings	(33,491.00)
Payment for Capital Additions of Property, Plant and Equipment	0.00
Increase in Receivables from Sales on Account	2,604,048.36
Collection of Receivables	(1,799,918.56)
Additions to Allowance for Bad Debts	0.00
Bad Debts Written Off	0.00
Purchases of Inventory for Sale	870,873.17
Decrease in Inventories from Sales	(886,041.18)
Inventory Written Off	0.00
Capital Additions of Property, Plant and Equipment	0.00
Decrease from Depreciation and Amortization	(21,428.16)
Property, Plant and Equipment Written Off	0.00
Purchases of Inventory for Sale on Account	(2,983,739.70)
Decrease from Payment of Accounts Payable	1,889,636.81
Interest Accrued	0.00
Decrease from Payment of Interest	0.00
Additional Long-term Borrowings	(10,554.36)
Repayment of Long-term Borrowings	33,491.00
Investments by Owner	0.00
Distributions to Owner	0.00
Net Income (Loss)	1,351,122.32
Check Sum Changes	€ 0.00

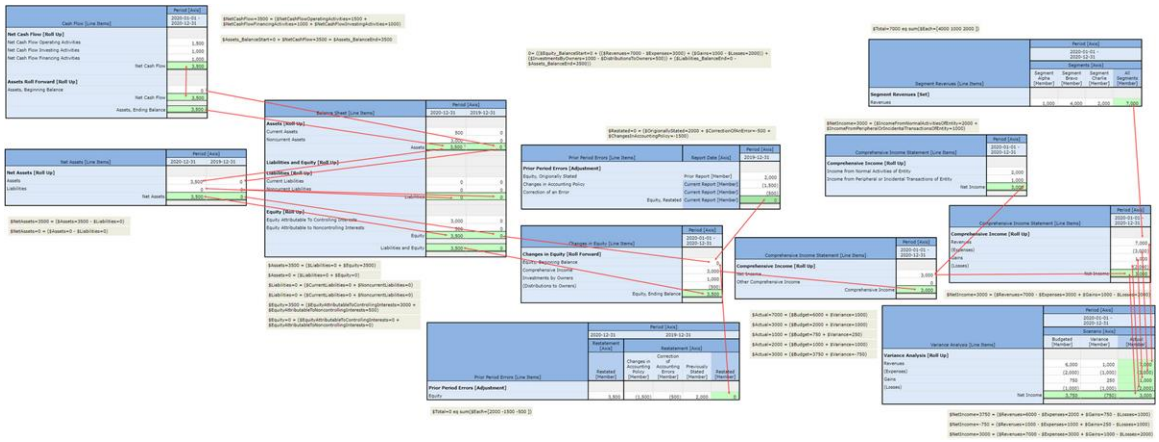
Note that if an event type is not provided for each transaction, then additional work is necessary in order to automatically generate a statement of cash flow and a statement of changes in equity.

2.13. Four Statement Report Model

There tend to be four core primary statements that make up a set of financial statements and all four reports are mathematically interconnected. The four core primary financial statements are:

- Balance sheet
- Income statement
- Statement of changes in equity
- Cash flow statement

In addition to the four core primary financial statements being mathematically interconnected, many disclosures are mathematically connected to specific disclosures which disaggregate line items on a financial report (roll ups) or detail changes in line items (roll forwards). The following graphic helps to understand these mathematical interconnections[15]:



2.14. Report Writer

A report writer is a mechanism that takes the information within a double-entry bookkeeping system and then generates a report. The primary task of a report writer is to:

- Map the accounts to the specific line items of a report
- Specify the full hierarchy of the report line items, sub totals, groupings, etc.

A lead schedule is a tool for creating this mapping which is used by auditors. See a portion of a lead schedule below:

Concept [Aspect]	Period [Aspect] / 2022-12-31 / Status [Dimension]		
	Prepared by Client [Member]	Adjustments [Member]	Adjusted [Member]
Cash and Cash Equivalents [Roll Up]			
000-1100-00 - BofA Checking	$ 40,000	$ 0	$ 40,000
000-1105-00 - Payroll imprest account - B of A	15,000	0	15,000
000-1107-00 - Petty cash on hand	5,000	0	5,000
Cash and Cash Equivalents (WTB)	$ 60,000	$ 0	$ 60,000
Trade Accounts Receivable [Roll Up]			
000-1200-00 - AR	$ 180,000	$ 50,000	$ 230,000
Trade Accounts Receivable (WTB)	$ 180,000	$ 50,000	$ 230,000

[15] *PROOF Articulation*, https://www.xbrlsite.com/seattlemethod/platinum/proof/PROOF_Articulation.jpg

What is shown is the three accounts from a chart of accounts that make up the balance sheet line item "Cash and Cash Equivalents". This is the first primary task of a report writer.

The second primary task is to indicate where the line item "Cash and Cash Equivalents" shows up in a report. This can be specified using a report model. For example, here is a report model prototype represented using XBRL[16]:

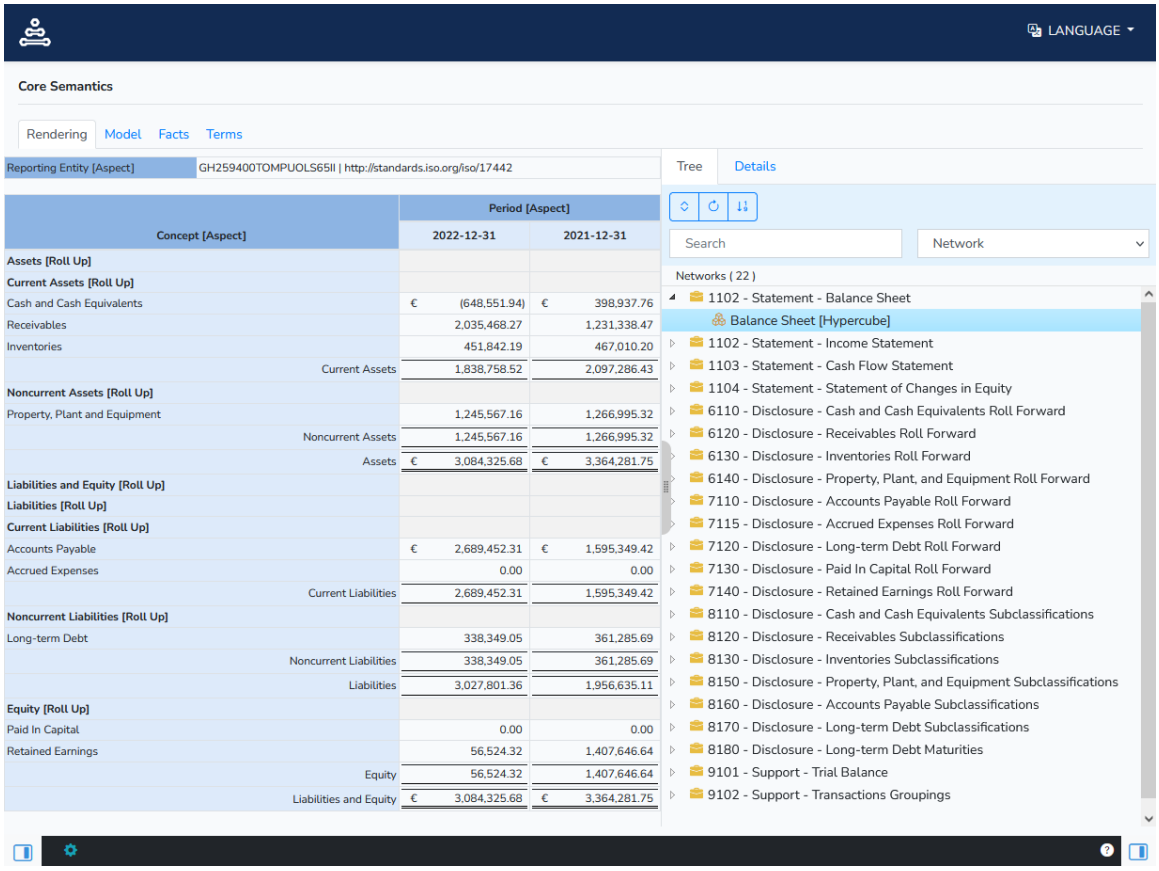
Line		Object Class	Period Type	Balance	Report Element
1	1102 - Statement - Balance Sheet	Network			http://xbrlsite.com/mini/role/level4/BalanceSheet
2	**Balance Sheet [Hypercube]**	Hypercube			mini:BalanceSheetHypercube
3	**Balance Sheet [Line Items]**	LineItems			mini:BalanceSheetLineItems
4	Assets [Roll Up]	Abstract			mini:AssetsRollUp
5	Current Assets [Roll Up]	Abstract			mini:CurrentAssetsRollUp
6	Cash and Cash Equivalents	Concept (Monetary)	As Of	Debit	mini:CashAndCashEquivalents
7	Receivables	Concept (Monetary)	As Of	Debit	mini:Receivables
8	Inventories	Concept (Monetary)	As Of	Debit	mini:Inventories
9	Current Assets	Concept (Monetary)	As Of	Debit	mini:CurrentAssets
10	Noncurrent Assets [Roll Up]	Abstract			mini:NoncurrentAssetsRollUp
11	Property, Plant and Equipment	Concept (Monetary)	As Of	Debit	mini:PropertyPlantAndEquipment
12	Noncurrent Assets	Concept (Monetary)	As Of	Debit	mini:NoncurrentAssets
13	Assets	Concept (Monetary)	As Of	Debit	mini:Assets
14	Liabilities and Equity [Roll Up]	Abstract			mini:LiabilitiesAndEquityRollUp
15	Liabilities [Roll Up]	Abstract			mini:LiabilitiesRollUp
16	Current Liabilities [Roll Up]	Abstract			mini:CurrentLiabilitiesRollUp
17	Accounts Payable	Concept (Monetary)	As Of	Credit	mini:AccountsPayable
18	Accrued Expenses	Concept (Monetary)	As Of	Credit	mini:AccruedExpenses
19	Current Liabilities	Concept (Monetary)	As Of	Credit	mini:CurrentLiabilities
20	Noncurrent Liabilities [Roll Up]	Abstract			mini:NoncurrentLiabilitiesRollUp
21	Long-term Debt	Concept (Monetary)	As Of	Credit	mini:LongtermDebt
22	Noncurrent Liabilities	Concept (Monetary)	As Of	Credit	mini:NoncurrentLiabilities
23	Liabilities	Concept (Monetary)	As Of	Credit	mini:Liabilities
24	Equity [Roll Up]	Abstract			mini:EquityRollUp
25	Paid In Capital	Concept (Monetary)	As Of	Credit	mini:PaidInCapital
26	Retained Earnings	Concept (Monetary)	As Of	Credit	mini:RetainedEarnings
27	Equity	Concept (Monetary)	As Of	Credit	mini:Equity
28	Liabilities and Equity	Concept (Monetary)	As Of	Credit	mini:LiabilitiesAndEquity

2.15. Report

A report is considered, in this case, all information that can be effectively generated from the information contained within the general ledger trial balance using the report writer. Here is an example report provided by Luca Suite, a product of Pacioli.ai[17]:

[16] Report Model Prototype, http://www.xbrlsite.com/seattlemethod/platinum/mini/base-taxonomy/mini_ModelStructure.html

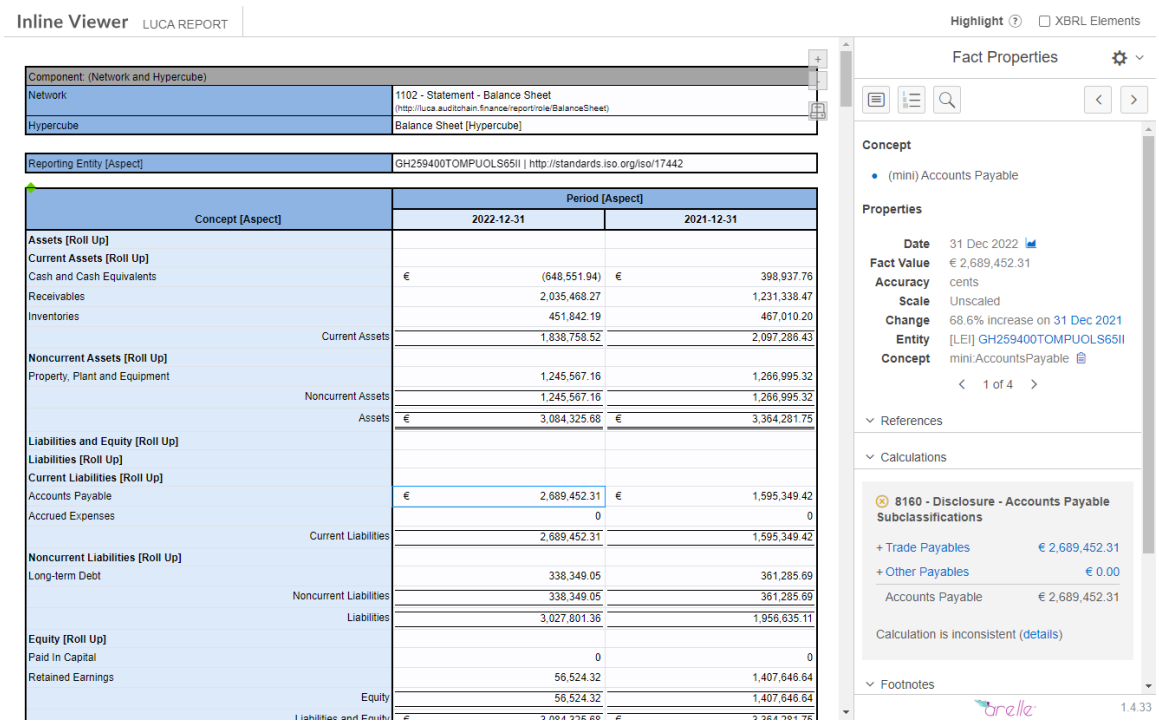
[17] Report viewer, https://luca.pacioli.ai/luca/view/0f24fd35e961e167a727b663c75a4c5ec9fb7eb86730d6292f46e6e180fc201847386214/index



Concept [Aspect]	Period [Aspect] 2022-12-31	2021-12-31
Assets [Roll Up]		
Current Assets [Roll Up]		
Cash and Cash Equivalents	€ (648,551.94)	€ 398,937.76
Receivables	2,035,468.27	1,231,338.47
Inventories	451,842.19	467,010.20
Current Assets	1,838,758.52	2,097,286.43
Noncurrent Assets [Roll Up]		
Property, Plant and Equipment	1,245,567.16	1,266,995.32
Noncurrent Assets	1,245,567.16	1,266,995.32
Assets	€ 3,084,325.68	€ 3,364,281.75
Liabilities and Equity [Roll Up]		
Liabilities [Roll Up]		
Current Liabilities [Roll Up]		
Accounts Payable	€ 2,689,452.31	€ 1,595,349.42
Accrued Expenses	0.00	0.00
Current Liabilities	2,689,452.31	1,595,349.42
Noncurrent Liabilities [Roll Up]		
Long-term Debt	338,349.05	361,285.69
Noncurrent Liabilities	338,349.05	361,285.69
Liabilities	3,027,801.36	1,956,635.11
Equity [Roll Up]		
Paid In Capital	0.00	0.00
Retained Earnings	56,524.32	1,407,646.64
Equity	56,524.32	1,407,646.64
Liabilities and Equity	€ 3,084,325.68	€ 3,364,281.75

Here is another alternative report, Inline XBRL provided within an Inline XBRL viewer[18]:

[18] Inline XBRL, https://luca.pacioli.ai/storage/aa03cb7b-e95e-405e-b3e1-9fe4e893e5a5/b60e0a16/ixbrl-report-viewer.html



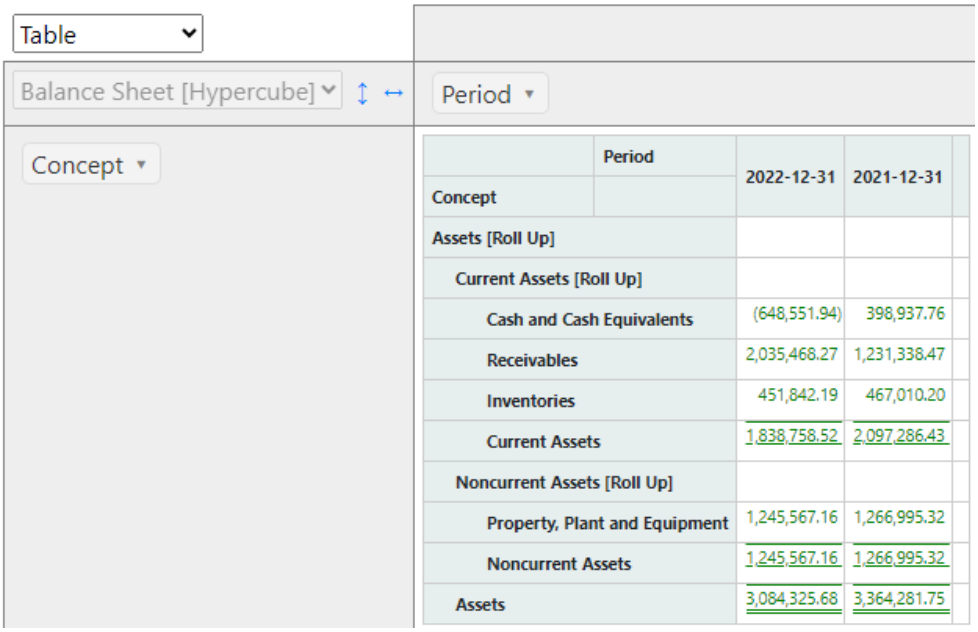
2.16. Analysis

Ultimately, the objective of generating a report is to analyze the information contained within the report. There tends to be three typical scenarios when analyzing a report:

- Analyze information within one specific report
- Period analysis where information for one economic entity is analyzed across many reporting periods
- Entity analysis where information for multiple economic entities, perhaps peers, is analyzed and compared as of one reporting period

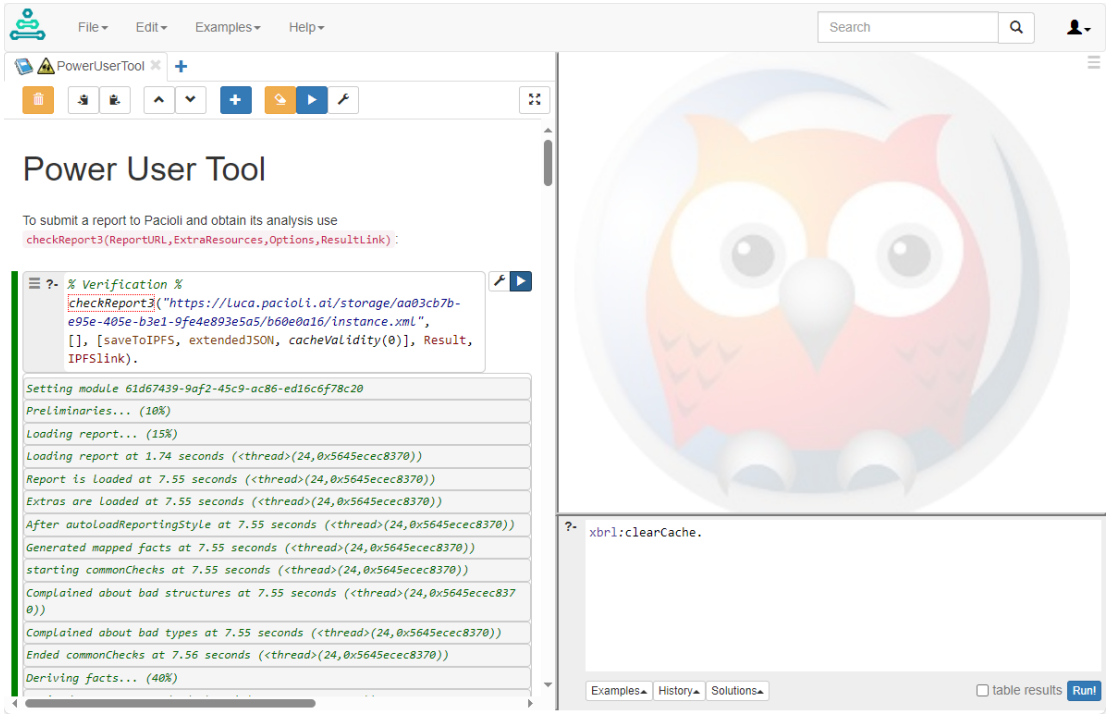
One example tool for providing report analysis is Pacioli.ai. Here is a Pacioli Technical Analysis tool which is used to verify XBRL-based reports and slice/dice report information[19].

[19] Pacioli Technical Analysis Tool, https://auditchain.infura-ipfs.io/ipfs/QmNnz7XkULArCyaTLp4mbicUEuZRjL8DxuJPjk3vqUSKba/



Concept	Period	2022-12-31	2021-12-31
Assets [Roll Up]			
Current Assets [Roll Up]			
Cash and Cash Equivalents		(648,551.94)	398,937.76
Receivables		2,035,468.27	1,231,338.47
Inventories		451,842.19	467,010.20
Current Assets		1,838,758.52	2,097,286.43
Noncurrent Assets [Roll Up]			
Property, Plant and Equipment		1,245,567.16	1,266,995.32
Noncurrent Assets		1,245,567.16	1,266,995.32
Assets		3,084,325.68	3,364,281.75

What may not be obvious is that all the report information is loaded into an SWI-PROLOG[20] in memory database which is then available for a user to query any information which exists within the report:

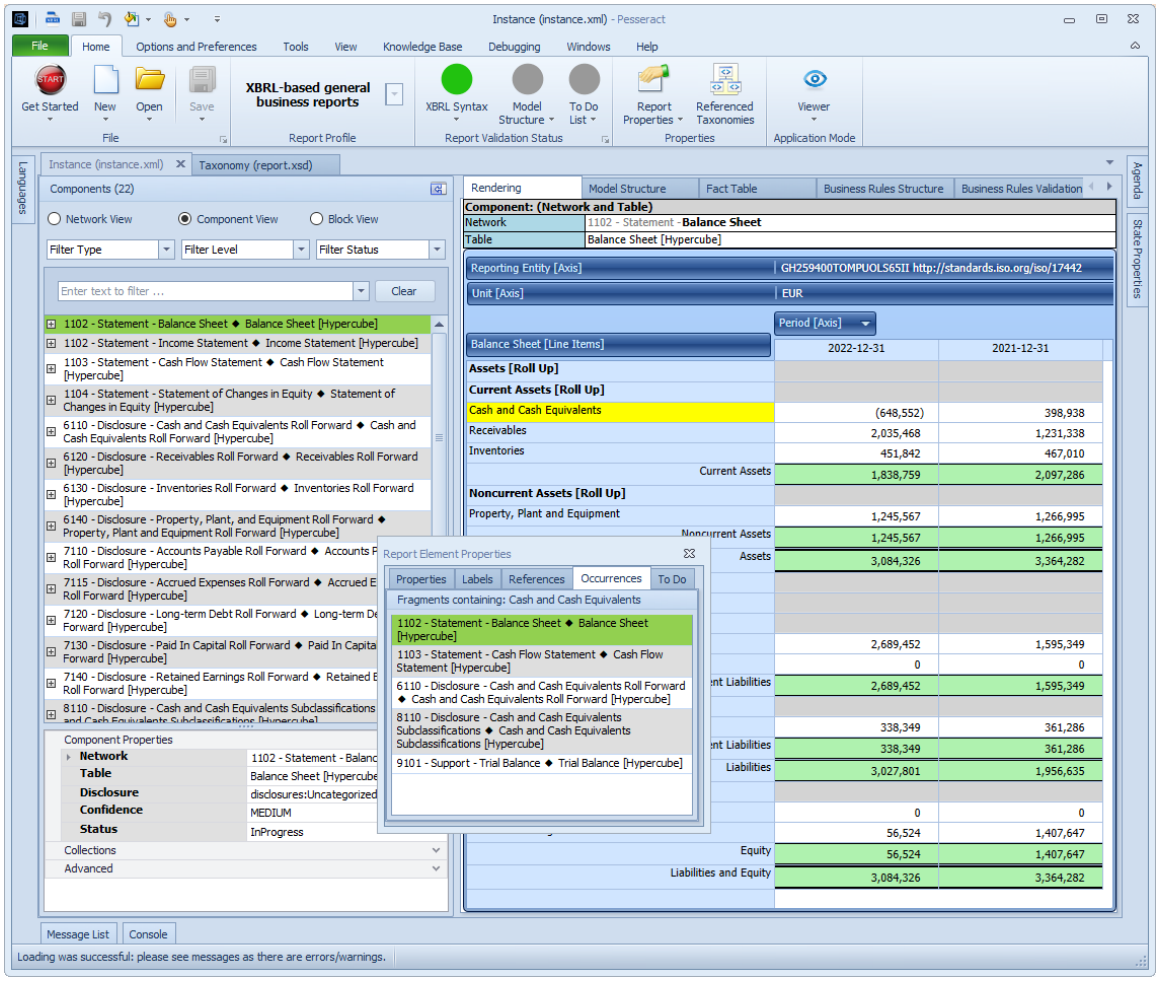


Discussing how to query the financial report information is beyond the scope of this document, but I can say that it currently requires

[20] SWI-Prolog, https://www.swi-prolog.org/

knowledge of PROLOG to query report information. Eventually, a higher level query language will be provided which abstracts away the need for PROLOG syntax knowledge.

Another tool with a significantly better user interface is the working prototype XBRL-based report viewing tool, Pesseract.



The point of showing Pesseract which is a desktop application written using Microsoft.Net is that it shows that nice looking, easy to use interfaces can be effectively created.

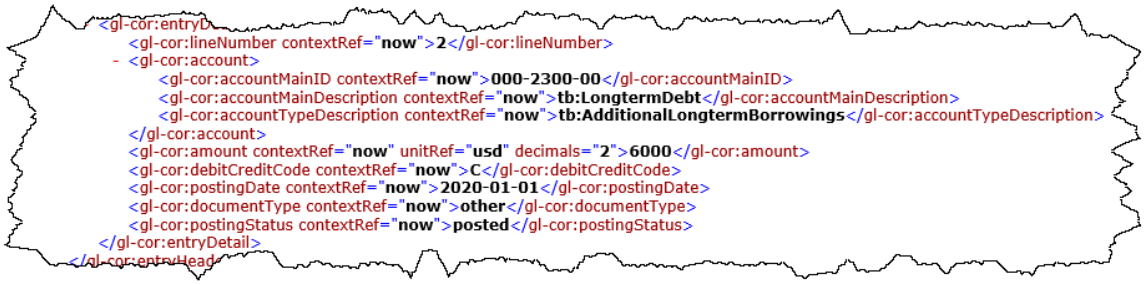
2.17. Drill Down or Up

The ultimate objective of this narrative is to explain that using the mechanisms outlined in this narrative; it is possible to navigate:

- from any journal entry to the financial report line item into which the journal entry rolls up,

- from any financial report line item down to the journal entry(s) which make up that line item,
- from every change in any balance sheet account (roll forward) and down to the detailed journal entries that make up that change

How is the above possible? The drill downs or drill ups are possible because: (1) all journal entries are extracted from the double-entry bookkeeping system and provided using the XBRL Global Ledger format, (2) all the necessary semantic information necessary to achieve the drill downs or drill ups is provided and properly aligned, and (3) software that leverages the availability of the information and understands the information semantics and the XBRL technical format is available to perform these tasks effectively.



Besides, the XBRL-based reports created were generated automatically from the double-entry bookkeeping system journal entries and the metadata available to that system. The system is complete and aligned and software is used to verify that everything is working as it should be working.

For more details, please refer to *Effective Automation of Record to Report Narrative Iteration #4*[21].

2.18. Summary

Typically, accountants that make use of double-entry bookkeeping systems are not necessarily that good at setting up those systems effectively. If information is missing from such a system, such as the event type information, performing certain tasks becomes more challenging, if not impossible.

[21] Charles Hoffman, CPA, *Effective Automation of Record to Report Process Narrative for Iteration #4*, https://xbrlsite.azurewebsites.net/2021/prototypes/recordToReport/NarativeForIteration4.pdf

3. Axioms, Theorems, Ethics/Worldview

Axioms describe self-evident logical principles that no one would argue with. Axioms deal with primitives and fundamentals. Theorems are deductions which can be proven by constructing a chain of reasoning by applying axioms in the form of IF…THEN statements. Ethics is the worldview of a double-entry bookkeeping system and financial report generated from that system.

While axioms are irrefutable facts which form a foundation, which describes a financial report and theorems build on those axioms by deduction and therefore both axioms and theorems are objective; the ethics or worldview which describes a financial report can be more subjective. Observation, experience, introspection, and intuition determine the worldview; not tightly reasoned arguments.

This section summarizes the axioms, theorems, and ethics/worldview of a double-entry bookkeeping system.

3.1. Sum of DEBITS must always equal the sum of CREDITS

Within a double-entry system, the sum of DEBITS must always equal the sum of CREDITS with the journal and within the ledger at all times. It is the responsibility of the system to always make sure that DEBITS=CREDITS.

3.2. Transactions must never be deleted

Once posted, transactions within a journal or ledger must never be deleted or otherwise removed. Correcting for an error is always achieved by posting an additional transaction or transactions to correct for the error.

3.3. Accounts must be provided for

A set of accounts, documented within the chart of accounts, must always be provided. A token for every account is provided.

3.4. Accounts must always be assigned to an account type

Accounts are always associated with an account type.

3.5. Business events supported by the system must be provided.

A complete set of business events supported by the double-entry bookkeeping system must be provided to the system for the system to

make use of to enter transactions. A token for every event type is provided to the system.

3.6. Prudence dictates that extracting and making use of information from a financial report should not be a guessing game

This should be self-evident.

4. Implementation

Implementation of a double-entry bookkeeping system is beyond the scope of this document. However, it is important to understand that every implementation of the semantics and logic provided in this document should be exactly the same regardless of the implementation approach.

Further, certain assumptions can be made although it is highly advisable that assumptions should be avoided and explicit information is deemed best.

4.1. Single Currency

The semantics defined by this model support multiple currencies within the double-entry system. However, if information about the currency of amounts is not explicitly provided; it can be assumed that all amounts are in the same currency. However, if no information is provided to indicate precisely what the currency is; then it is possible to assume an incorrect currency of amounts.

4.2. Single Economic Entity

The semantics defined by this model support multiple reporting economic entities within the double-entry system. However, if information about the economic entity of the amounts is not explicitly provide; it can be assumed that all amounts relate to the same economic entity. However, if no information is provided to indicate precisely what economic entity amounts are reported for; then it is possible to assume the incorrect economic entity.

4.3. Event Type

The semantics defined by this model support formal event type information for each transaction within the double-entry system. However, it is possible to supplement the information within the system later in the process of generating financial reports.

4.4. Example Implementation

Here is an example implementation: (coming soon; for the time being, refer to the two links below)

https://luca.pacioli.ai/luca/view/0f24fd35e961e167a727b663c75a4c5ec9fb7eb86730d6292f46e6e180fc201847386214/index

https://xbrlsite.azurewebsites.net/2021/prototypes/recordToReport/NarativeForIteration4.pdf

4.5. Subledgers

As stated, this core semantics model supports the foundation or fundamentals of the double-entry bookkeeping model and only the general ledger is supported. This is a conscious choice made for a specific reason.

Every double-entry bookkeeping system must support the core semantic model, every subledger. That makes sense given that all transaction information ultimately flows through the general ledger.

This is not to say that subledgers are unimportant and not necessary. When any amount of additional complexity is induced into an economic entity, subledgers are a necessary accounting tool. Only the smallest of economic entities, the smallest businesses can use only a general ledger to run their bookkeeping needs.

Every subledger builds on the core semantics of double-entry bookkeeping, making specific needs of that specific subledger. Two common subledgers are accounts receivable/sales and accounts payable/expenses. But there are many other subledgers such as fixed assets, inventories, payroll, manufacturing, and I could go on and on and on.

The point is that sure, for many medium-sized or larger economic entities using a double-entry bookkeeping model certain specific additional subledgers would be necessary. Even for many smaller economic entities subledgers would be necessary.

But satisfying the needs of every economic entity is not the point of this document. The point of this document is to understand and document to core semantics of double-entry bookkeeping into which all those subledgers would need to effectively integrate.

The subledgers I leave for others.

4.6. Financial Accounts Only

By financial statement, what is meant in the case of core semantics of a double-entry bookkeeping system is only information about the financial accounts that flows through the ledger and trial balance.

While policies, qualitative disclosures, and other disclosures are part of a complete set of financial statements; this document focuses only on the information that flows through the ledger and trial balance.