1. Essence of Accounting

The purpose of this section is to provide a logical description of the essence of accounting and to demonstrate how accounting, reporting, auditing, and analysis can be performed digitally using a best practice-based method which employs an XBRL-based machine-readable representation of accounting information.

Essence is described as the core intrinsic nature or indispensable basic quality of something that determines its character.

We will cover the specific details of accounting, reporting, auditing, and analysis necessary to accomplish our objective.

This document strives to explain accounting to non-accountants such as computer scientists. Sometimes accountants are criticized for providing jargon filled explanations. I try and not make that mistake.

While there are people that say that old-school financial reporting processes need to be improved[1] and plenty of very good academic papers that help explain how accounting, reporting, auditing, and analysis in a digital environment might work including *Imagineering Audit 4.0*[2] and *Toward Blockchain-Based Accounting and Assurance*[3]; there is less information on exactly **how to** make these ideas work in software. This resource hopes to help fill that gap by providing a reliable and repeatable best practices-based method.

1.1. Fourth Industrial Revolution

Accounting evolves. Transactions were documented using physical objects before writing was invented. Clay tablets were employed at one point. Then papyrus. Then paper. Then e-paper such as PDF and HTML. Now comes machine-readable information.

Each of the four largest public accounting firms in one way or another tell their clients to get ready for big changes caused by the fourth industrial revolution[4]. One of those firms, Deloitte, articulates a particularly good vision which they refer to as *The Finance Factory*[5]. Deloitte envisions things like paperless core finance processes with a continuous, if not real time, financial close.

Another public accounting firm, PWC, predicts that global GDP will be 14% higher in 2030 as a result of artificial intelligence – the equivalent of an additional $15.7

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[1] *Changing Old School Financial Report Creation Processes*, http://xbrl.squarespace.com/journal/2017/2/14/changing-old-school-financial-report-creation-processes.html

[2] Jun Dai and Miklos Vasarhelyi, Rutgers University, *Imagineering Audit 4.0*, http://aaajournals.org/doi/abs/10.2308/jeta-10494?code=aaan-site

[3] Jun Dai and Miklos Vasarhelyi, Rutgers University, *Toward Blockchain-Based Accounting and Assurance*, http://aaajournals.org/doi/10.2308/isys-51804

[4] Charles Hoffman, CPA, *Adapting to Changes Caused by the Fourth Industrial Revolution*, http://xbrl.squarespace.com/journal/2019/8/4/adapting-to-changes-caused-by-the-fourth-industrial-revoluti.html

[5] Charles Hoffman, CPA, *Deloitte's Vision: The Finance Factory*, http://xbrl.squarespace.com/journal/2019/2/20/deloittes-vision-the-finance-factory.html

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trillion increase in GDP which makes AI the biggest commercial opportunity in today's economy[6]. PWC is investing $3 billion to upskill their staff[7].

All of these changes can be embodied in the notation of computational professional services[8].

Accountants, don't under estimate the value of double-entry bookkeeping and the other processes, procedures, and techniques employed to make sure that everything "ticks and ties" and "cross casts and foots". These useful techniques, even perhaps better referred to as ingrained medieval traditions, should make their way into these new modern accounting techniques and methods. These successful and important medieval techniques are still very relevant even in the digital age.

1.2. Three Key Technologies Building on Medieval Traditions

Accounting, which has existed for 7,000 years[9], even before the creation of formal number systems, is constantly evolving. Accounting is about to go through another significant phase in that evolution process.

There are three specific new enabling technologies that can be leveraged to significantly improve and modernize accounting, reporting, auditing, and analysis. Those technologies will transition into the mainstream over the coming years. Those three technologies are[10]:

- **Structured information** such as XBRL-based structured digital financial reports and other such machine-readable information formats for exchanging information[11].
- **Knowledge-based systems** and other applications of artificial intelligence; at first primarily rules-based systems and then ultimately patterns-based systems (i.e. machine learning)[12].
- **Digital distributed ledgers** using blockchain, hashgraph, hyperledger, or other such technologies that enable the creation of immutable public or private ledgers[13] enhanced by smart contracts[14] and logic contracts[15].

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[6] Charles Hoffman, CPA, *Artificial Intelligence Done Right*, http://xbrl.squarespace.com/journal/2019/10/19/artificial-intelligence-done-right.html

[7] Charles Hoffman, CPA, *PWC to Invest $3 Billion in Upgrading Skills*, http://xbrl.squarespace.com/journal/2019/10/12/pwc-to-invest-3-billion-in-upgrading-skills.html

[8] Charles Hoffman, CPA, *Computational Professional Services*, http://www.xbrlsite.com/mastering/Part00_Chapter01.A1_ComputationalProfessionalServices.pdf

[9] Wikipedia, History of Accounting, retrieved June 10, 2017, https://en.wikipedia.org/wiki/History_of_accounting

[10] Charles Hoffman, CPA, *Modernizing Accounting and Auditing: Three Technology Trends*, http://xbrl.squarespace.com/journal/2017/5/27/modernizing-accounting-and-auditing-three-technology-trends.html

[11] Charles Hoffman, CPA, *Special Theory of Machine-based Automated Communication of Semantic Information of Financial Statements*, http://xbrlsite.azurewebsites.net/2019/Library/SpecialTheoryOfSemanticCommunicationOfFinancialInformation.pdf

[12] Charles Hoffman, CPA, *Artificial Intelligence and Knowledge Engineering in a Nutshell*, http://xbrlsite.azurewebsites.net/2019/Library/KnowledgeEngineeringInNutShell.pdf

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Trying to understand these changes from the perspective of today's accounting, reporting, auditing, and analysis practices will not help you understand these coming changes. To understand the changes you have to understand how computers work which is explained in Computer Empathy[16].

The territory has changed. A paradigm shift has occurred. But, by understanding the essence of accounting it is possible to understand possible futures of accounting, reporting, auditing, and analysis.

1.3. Systems

A **system** is a cohesive conglomeration of interrelated and interdependent parts that is either natural or man-made. **Logic** is thinking according to a set of consistent and coherence rules. A logical system (a.k.a. formal system, axiomatic system, conceptual model) enables a community of stakeholders trying to achieve a specific goal or objective or a range of goals/objectives to agree on important common models, structures, and statements for capturing meaning or representing a shared understanding of and knowledge in some universe of discourse.

A general purpose financial report is a complicated logical system invented by humans to achieve a specific purpose.

1.4. System Complexity and Order

Difference systems have different levels complexity. Systems can also be ordered or disordered. The Cynefin Framework[17] is a conceptual framework that helps you understand the dynamics that are at work within different types of systems. The framework was created in 1999 by David Snowden of IBM Global Services to help IBM to manage intellectual capital.

The following graphic helps one understand the different levels of complexity: simple, complicated, complex, and chaotic. The graphic also helps one understand the difference between disorder and order.

The video *Using Cynefin to Prioritize and Analyze Features, User Stories, and Functional Requirements*[18] provides an excellent walk through of these ideas.

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[13] Charles Hoffman, CPA, Digital Distributed Ledgers, http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.71_DistributedLedgers.pdf

[14] Wikipedia, *Smart Contracts*, https://en.wikipedia.org/wiki/Smart_contract

[15] *Logical Contracts*, http://logicalcontracts.com/

[16] Charles Hoffman, CPA, *Computer Empathy*, http://www.xbrlsite.com/mastering/Part00_Chapter01.C_ComputerEmpathy.pdf

[17] Cynefin Framework, http://xbrl.squarespace.com/journal/2021/3/21/cynefin-framework.html

[18] Using Cynefin to Prioritize and Analyze Features, User Stories, and Functional Requirements, https://www.youtube.com/watch?v=L5fnxahydXM

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Different skill sets are necessary to be able to create simple, complicated, and complex systems that work effectively.

Accounting information tends to be simple and complicated per the definitions of the Cynefin framework.

1.5. Change

Things change, even financial reporting standards. This discussion paper, *Preliminary Views on Financial Statement Presentation*[19], provides insight as to how the FASB thinks about financial statements.

1.6. Brief History of Accounting

Between 5,000 and 10,000 years ago farmers in Mesopotamia, where agriculture was born, used physical objects to count crops and animals[20]. The distinction between types of crops or animals was made by using different types and shapes of objects. Then, in about 3200 BC, around 5,000 years ago, the first spreadsheet was invented.

1.7. Spreadsheets

These farmers began documenting information using clay tablets in the earliest form of human writing ever discovered called Cuneiform. They partitioned their clay

[19] FASB, *Preliminary Views on Financial Statement Presentation*, https://www.fasb.org/DP_Financial_Statement_Presentation.pdf
[20] Denise Schmandt-Bessersat, *On the origins of writing*, YouTube.com, https://www.youtube.com/watch?v=kidWY-pJFb0

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tablet into rows, columns, and cells. These farmers used single-entry accounting. The spreadsheet below documents an account of barley distribution[21]:

1.8. Invention and Documentation of Double-entry System

In 1211 AD a bank in Florence was the first documented use of double-entry accounting[22]. Around 1300 AD double-entry accounting came of age. In 1494 AD during the Renaissance, Venetian mathematician and Franciscan friar Luca Pacioli[23] published a book, *Summa de arithmetica, geometria. Proportioni et proportionalita* (Sum of Arithmetic, Geometry, Proportion and Proportionality)[24]. That book documented an approach to accounting now called double-entry bookkeeping[25] and recommended that others use this approach. The approach allowed for better error

[21] Metropolitan Museum, Proto-Cuneiform tablet with seal impressions: administrative account of barley distribution with cylinder seal impression of a male figure, hunting dogs, and boars, https://www.metmuseum.org/art/collection/search/329081

[22] Geoffrky Alan Lee, *The Development of Italian Bookkeeping 1211–1300*, Wiley, https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1467-6281.1973.tb00183.x

[23] Wikipedia, Luca Pacioli, https://en.wikipedia.org/wiki/Luca_Pacioli

[24] Wikipedia, Summa de arithmetica, https://en.wikipedia.org/wiki/Summa_de_arithmetica

[25] Ancient double-entry bookkeeping. Lucas Pacioli's treatise (A. D. 1494--the earliest known writer on bookkeeping) reproduced and translated with reproductions, notes and abstracts from Manzoni, Pietra, Mainardi, Ympyn, Stevin and Dafforne, https://archive.org/details/ancientdoubleent00geij/page/n3/mode/2up

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detection and the ability to differentiate unintended errors from fraud. Accountants adopted that new approach.

Another book documenting double-entry accounting was *Della mercatura e del mercante perfetto*[26] (translated *Of commerce and the perfect merchant*) which was written by Benedetto Cotrugli in 1458 but it was not published until 1573.

1.9. Double-entry Accounting

At the foundation of every financial reporting scheme is the double-entry accounting model[27]. Simply stated, that model is: **DEBITS = CREDITS**. The double-entry accounting model is a mathematical model. (If you don't understand this double-entry accounting, this video is helpful[28]!)

Single-entry bookkeeping[29] is how 'everyone' would do accounting. In fact, that is how accounting was done before double-entry bookkeeping was invented. Single-entry bookkeeping simply uses one list to record information about transactions.

Double-entry accounting in essence uses two lists of information and the two lists are compared/synchronized to one another and the two lists must agree.

Double-entry bookkeeping[30] adds an additional important property to an accounting system, that of a clear strategy to identify errors and to remove the errors from the system.

Even better, it has a side effect of clearly firewalling errors as either accident or fraud. This then leads to the ability to specify an audit strategy. Double-entry bookkeeping is how professional accountants do accounting.

And so, double-entry bookkeeping was the invention of medieval merchants and was first documented by the Italian mathematician and Franciscan Friar Luca Pacioli[31].

Double-entry bookkeeping is perhaps one of the greatest discoveries and its impact on commerce and its significance is difficult to overstate. Which came first, double-entry bookkeeping or the enterprise[32]? Was it double-entry bookkeeping and what it offered that enable the large enterprise to exist; or, did the large enterprise create the need for double-entry bookkeeping?

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[26] Wikipedia, *Della mercatura e del mercante perfetto*, https://en.wikipedia.org/wiki/Della_mercatura_e_del_mercante_perfetto
[27] David P. Ellerman, *The Mathematics of Double Entry Bookkeeping*, http://www.ellerman.org/wp-content/uploads/2012/12/DEB-Math-Mag.CV_.pdf
[28] YouTube, *2016 Debit Credit Theory Accounting Rap Song from O'Neill High School*, https://www.youtube.com/watch?v=PHanSCcMb_I
[29] Wikipedia, *Single-entry Bookkeeping System*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Single-entry_bookkeeping_system
[30] Wikipedia, *Double-entry Bookkeeping System*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Double-entry_bookkeeping_system
[31] Wikipedia, *Luca Pacioli*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Luca_Pacioli
[32] Ian Grigg, *Triple Entry Accounting, A Very Brief History of Accounting, Which Came First - Double Entry or the Enterprise?,* http://iang.org/papers/triple_entry.html

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1.10. Foundational Mathematical Equation for Double-Entry Accounting

The foundational basis of double-entry accounting is straightforward. Quoting David Ellerman from his paper *The Math of Double-Entry Bookkeeping: Part I (scalars)*[33]:

> "Given an equation w + … + x = y + … + z, it is not possible to change just one term in the equation and have it still hold. Two or more terms must be changed."

And so, the left-hand side of the equation "w + … + x" (the DEBIT side) must always equal the right-hand side of the equation "y + … + z" (the CREDIT side) in double-entry accounting.

The reason that double-entry accounting is used, as contrast to single-entry accounting, is double-entry accounting's capability to detect errors and to distinguish an error from fraud.

Of course, there are a lot of details associated with setting up and operating an accounting system appropriately, but the fundamental feature is that DEBITS must equal CREDITS and if they don't, then something is up which needs to be investigated and corrected.

1.11. Mathematics of Double Entry Accounting

Mathematics Magazine published an article written by David Ellerman, *The Mathematics of Double Entry Bookkeeping*[34], where Ellerman points out that double entry accounting 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."

When one takes the time to look, they see that the mathematics of double entry accounting relate to the mathematical concepts of *scalers*[35] and *vectors*[36]. Accountants don't use these terms; rather they use the notion "DEBITS = CREDITS" (i.e. scalers) and "BASE" (i.e. vectors). The former notion we have explained. BASE is simply the notion or acronym of a roll forward stated:

Beginning Balance + **A**dditions - **S**ubtractions = **E**nding Balance

Another term for BASE and roll forward is "movements" or "movements analysis".

1.12. Accounting Equation

Building on the double-entry accounting model is the accounting equation[37]. Assets (a debit) is always equal to the sum of Liabilities (a credit) plus Equity (a credit). This is essentially a second layer building on the first layer. The foundational semantics of double-entry accounting is the accounting equation:

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[33] David Ellerman, *The Math of Double-Entry Bookkeeping: Part I (scalars)*, http://www.ellerman.org/the-math-of-double-entry-bookkeeping-part-i-scalars/

[34] David Ellerman, *The Mathematics of Double Entry Bookkeeping*, http://www.ellerman.org/wp-content/uploads/2012/12/DEB-Math-Mag.CV_.pdf

[35] Wikipedia, *Scalers (Mathematics)*, https://en.wikipedia.org/wiki/Scalar_(mathematics)

[36] Wikipedia, Vectors (Mathematics and Physics), https://en.wikipedia.org/wiki/Vector_(mathematics_and_physics)

[37] Wikipedia, *Accounting Equation*, https://en.wikipedia.org/wiki/Accounting_equation

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"Assets = Liabilities and Equity"

The terms "assets", "liabilities", and "equity" have very specific and generally well understood meanings in accounting and business. Accounting is referred to as "the language of business". This high-level accounting equation is broken down into two trees of information. Those two trees are the detailed items which make up a financial report, "Assets" and "Liabilities and Equity". The semantics reiterates what that foundational equation states and assigns meaning to the numbers that make up those DEBITS and CREDITS.

Empirical evidence gathered shows that there are a finite number of ways used to organize the high-level concepts that make up the three primary financial statements: balance sheet, income statement, cash flow statement. I call these different organizations reporting styles[38].

1.13. Financial Reporting Schemes

As explained by the FASB in SFAC 6[39], "Elements of financial statements are the building blocks with which financial statements are constructed—the classes of items that financial statements comprise. The items in financial statements represent in words and numbers certain entity resources, claims to those resources, and the effects of transactions and other events and circumstances that result in changes in those resources and claims."

Financial standards setters or perhaps regulators create reporting schemes. Every financial reporting scheme fundamentally adheres to the accounting equation in some form. Creators of financial reporting schemes tend to create a set of high-level financial concepts that map directly to assets, liabilities, and equity and the rule "assets = liabilities + equity".

Here is a comparison of the core set of interrelated elements defined by five different financial reporting schemes[40].

Reporting Scheme	**US GAAP issued by FASB**	**IFRS issued by IASB**	**FRF for SMEs issued by AICPA**	**IPSAS issued by IPSASB**	**GAS issued by GASB**
Assets	Assets	Assets	Assets	Assets; Other Resources	Assets and Deferred Inflow of Resources
Liabilities	Liabilities	Liabilities	Liabilities	Liabilities; Other Obligations	Liabilities and Deferred Outflow of Resources
Equity or Net Assets	Equity (or Net Assets)	Equity (or Net Assets)	Equity (or Net Assets)	Net Financial Position	Net Position
Comprehensive Income	Comprehensive Income	Income and Expenses	Net income	Surplus or Deficit	Change in Net Position
Investments by Owners	Investments by Owners	Contributions from Holders of Equity Claims	Investments by Owners	Ownership Contributions	Increase in Net Position (Implied)
Distributions to Owners	Distributions to Owners	Distributions to Holders of Equity Claims	Distributions to Owners	Ownership Distributions	Decrease in Net Position (Implied)
Revenues	Revenues	Income	Revenues	Revenues	Inflow of Resources
Expenses	Expenses	Expenses	Expenses	Expenses	Outflow of Resources
Gains	Gains		Gains		
Losses	Losses		Losses		

[38] Charles Hoffman, *Making the Case for Reporting Styles*, http://xbrlsite.azurewebsites.net/2017/library/MakingTheCaseForReportingStyles.pdf
[39] FASB, SFAC 6, Elements of Financial Statements, page 14.
[40] Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*, http://xbrlsite.azurewebsites.net/2019/core/ElementsOfFinancialStatements.pdf

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On the one hand, the unique aspects of an economic entity need to be articulated. On the other hand, investors and financial analysts need to be able to compare the financial position and financial performance of different economic entities. Standard financial reporting schemes strive to strike an appropriate balance.

While it is true that the definitions of what constitutes these high-level concepts can be different per different reporting schemes, the high-level model is the same and the mechanics of a financial report tend to be far more similar than different between different financial reporting schemes. That model is explainable using basic math.

1.14. Interrelated Elements of Financial Statements

Every financial reporting scheme defines a core set of interrelated elements of a financial statement that are fundamentally grounded in some form of the accounting equation. For example, the Financial Accounting Standards Board (FASB) defines these ten interrelated elements of a financial statement in SFAC 6[41]; Assets, Liabilities, Equity, Comprehensive Income, Investments by Owners, Distributions to Owners, Revenues, Expenses, Gains, Losses. Then, additional elements are defined based on that core set. As is explained next, the interrelations of these elements are intentional.

1.15. Objective of Financial Reporting

The following problem description or business use case was inspired by a similar sort of description by Harry S. Delugach, Associate Professor of Computer Science, in a presentation, *Common Logic Standards Development*, (page 7). Fundamentally, a financial statement serves this purpose:

> Two economic entities, A and B, each have information about their financial position and financial performance. They must communicate their information to an investor who is making investment decisions which will make use of the combined information so as to draw some conclusions. All three parties (economic entity A, economic entity B, investor) are using a common set of basic logical principles (facts, statements, deductive reasoning, etc.), common financial reporting standard terms and associations between terms (terms, associations, structures, assertions for a reporting scheme US GAAP, IFRS, IPSAS, etc.), and a common world view so they should be able to communicate this information fully, so that any inferences which, say, the investor draws from economic entity A's information should also be derivable by economic entity A itself using common basic logical principles, common financial reporting standards (terms, associations, structures, rules), and common world view; and vice versa; and similarly for the investor and economic entity B.

This problem/use case has been effectively solved for hundreds of years via the use of paper-based and human readable general-purpose financial statements.

1.16. Financial Reports are Not Forms

General purpose financial statements are essentially "complex messages with variability". As explained by the FASB in SFAC 6, variability is an intentional,

[41] FASB, SFAC 6, Elements of Financial Statements, page 23.

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inherent characteristic of a financial statement. For example, per SFAC 6, page 47, paragraph 77[42:]

> "Examples of intermediate components in business enterprises are gross margin, income from continuing operations before taxes, income from continuing operations, and operating income. Those intermediate components are, in effect, subtotals of comprehensive income and often of one another in the sense that they can be combined with each other or with the basic components to obtain other intermediate measures of comprehensive income."

That statement describes the "intermediate components" that contribute to the variability of a financial report.

A financial report is essentially a graph as defined by graph theory[43]. A graph is a mathematical structure used to model pairwise relations between objects. Graphs don't really exist in the real world, but they are used to describe real world objects to things like computer software.

It would be appropriate to call a financial report a "knowledge graph" and an XBRL-based financial statement is a machine-readable knowledge graph. A "tree" is a special type of graph. So, let's use the term "tree". And so, imagine a financial report as a "tree" of information. Here is a tree:

And here is a "forest" of financial reports (i.e. a set of trees, for example the SEC EDGAR system might be considered a "forest" of financial reports:

But really, the forest above is not a good representation of US GAAP or IFRS forest of financial reports. The forest above assumes that all the "trees" are the same, which they are not because of the inherent variability of a financial report, the different

[42] Ibid.

[43] Wikipedia, *Network Theory*, https://en.wikipedia.org/wiki/Network_theory

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intermediate subtotals as previously described. And so, a "forest" of US GAAP or IFRS financial reports might better be represented by something more like this:

Due to the inherent variability of financial reports, they are not all the same. Yes, financial reports have similarities and they have patterns. But financial reports are not, and should not, be forms like the first forest.

But you can find patterns in the forest that is full of trees, the trees can be put into "sets" that have similarities. For example, those sets of financial reports when organized might look something like this:

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One might be tempted to call the forest seven different types of "forms" because unlike the one pattern in the first forest, we have seven patterns and therefore seven different types of forms. But this would not be accurate.

Think of each different tree being a different reporting style.

1.17. Understanding Intermediate Components

To understand the notion of intermediate components, consider the income statement. SFAC 6 clearly defines the components of comprehensive income to be[44]:

- Revenues
- Gains
- Expenses
- Losses

Those four components total to comprehensive income.

Further, if you read the definitions of the four components of comprehensive income the definitions of those four terms refer to the notions of "normal activities" and "peripheral activities". Therefore, comprehensive income can also be broken down like this:

- Income from Normal Activities of Entity
- Income from Peripheral or Incidental Transactions of Entity

Those two components likewise total to comprehensive income.

Reading the definitions of those four components of comprehensive income again, it is clear that "Revenues" and "Expenses" might not necessarily total to the component "Income from Normal Activities of Entity"; nor is it the case that "Gains" and "Losses" would total to "Income from Peripheral or Incidental Transactions of Entity".

It is likewise true that the typical financial report never reports their income statement using either of the above to breakdowns of comprehensive income. Income statement line items tend to be along the lines of the following components:

- Revenues (meaning revenues from normal activities or "operating" revenues)
- Cost of Revenues (meaning direct operating expenses)
- Gross Profit (Loss) (an intermediate subtotal)
- Operating expenses (meaning indirect operating expenses if the line item Cost of Revenues is reported)
- Other Operating Income (meaning operating gains that don't belong in the line item Revenues)
- Operating Income (Loss) (meaning the portion of comprehensive income relating to normal activities of the entity)
- Nonoperating Expenses (Income) (meaning peripheral or incidental expenses, gains, or losses)

[44] ibid, page 42, paragraph 65 B 1.

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- Income from Continuing Operations Before Taxes (an intermediate subtotal)
- Income Tax Expense (Benefit) (meaning taxes or benefits from normal or peripheral activities)
- Income from Continuing Operations After Taxes (an intermediate subtotal)
- Income (Loss) from Discontinued Operations (meaning a portion of income from normal activities that, however, have been discontinued)
- Net Income (Loss) (an intermediate subtotal)
- Net Income (Loss) Attributable to Parent (the portion of net income attributable to controlling interests)
- Net Income (Loss) Attributable to Noncontrolling Interests (the portion of net income attributable to noncontrolling interests)
- Other Comprehensive Income (meaning components that are specifically defined to be part of comprehensive income other than all other previous components)
- Comprehensive Income (defined by SFAC 6)

Now, this is only a portion of the intermediate components and subtotals that might exist on the income statements of most industries that take into considerations important ideas of "direct" versus "indirect" expenses; "operating" and "nonoperating"; "continuing" and "discontinued" operations; and other such important distinctions. Other industries such as banking have many completely different line items and subtotals that might be used.

Professional accountants understand these important distinctions and explaining the specifics of these distinctions are beyond the scope of this document. Further, there are nuances and subtleties that need to be considered when determining what line items and subtotals should be reported. These line items and subtotals are based, in part, on professional judgement and even personal preference sometimes but always need to be justifiable. Further, the logic of the specific line items and subtotals is both knowable and should make accounting sense.

1.18. Variability of Intermediate Components

Every financial report has inherent variability that is the result of explicitly allowing intermediate components of a financial report (i.e. subtotals) to be combined in appropriate but perhaps different ways depending on the needs of the reporting economic entity. Again, this is explained by the FASB in detail within SFAC 6[45].

There are a multitude of other patterns within financial reports that can be leveraged. For example, some financial reporting schemes require that each of the four primary financial statements be present within a set of financial statements in some form: balance sheet, income statement, statement of changes in equity, statement of cash flows. Disclosure notes such as the basis of reporting and nature of the economic entity providing the financial report are also deemed to be required because reports would leave out important details without these disclosure notes. These additional patterns which tend to be unique per financial reporting scheme are

[45] ibid, page 47, paragraph 77.

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beyond the scope of this basic explanation of the logical conceptualization of a financial report.

A financial **reporting scheme**[46] is a formal specification for how financial reports are to be created and the underlying accounting rules and is usually created by a standards setter or regulator. For example, US GAAP, IFRS, and IPSAS are all financial reporting schemes. Financial reports are not forms. Financial reporting schemes allow for a certain amount of flexibility and variability when reporting certain specific disclosures or subtotals contained within a disclosure.

1.19. Comparability Including Consistency

Per SFAS 8[47] issued by the FASB, page 19, QC23:

> "Comparability is not uniformity. For information to be comparable, like things must look alike and different things must look different. Comparability of financial information is not enhanced by making unlike things look alike any more than it is enhanced by making like things look different."

A form is uniformity. As stated, financial statements are not forms. And while financial statements are not forms, they are likewise not random either.

It is important to understand what the FASB means by "comparability (including consistency)". That is explained in SFAS 8[48]. Here is the pertinent section of that document. This is well stated, very clear, and every word is worth reading:

- **QC20**. Users' decisions involve choosing between alternatives, for example, selling or holding an investment, or investing in one reporting entity or another. Consequently, information about a reporting entity is more useful if it can be compared with similar information about other entities and with similar information about the same entity for another period or another date.
- **QC21**. Comparability is the qualitative characteristic that enables users to identify and understand similarities in, and differences among, items. Unlike the other qualitative characteristics, comparability does not relate to a single item. A comparison requires at least two items.
- **QC22**. Consistency, although related to comparability, is not the same. Consistency refers to the use of the same methods for the same items, either from period to period within a reporting entity or in a single period across entities. Comparability is the goal; consistency helps to achieve that goal.
- **QC23**. Comparability is not uniformity. For information to be comparable, like things must look alike and different things must look different. Comparability of financial information is not enhanced by making unlike things look alike any more than it is enhanced by making like things look different.

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[46] Reporting Scheme, http://xbrlsite.azurewebsites.net/2018/Library/ReportingSchemes-2018-12-30.pdf

[47] FASB, *Statement of Financial Accounting Concepts No. 8*, page 19, http://www.fasb.org/cs/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1175822892635&blobheader=application/pdf

[48] FASB, *Statement of Financial Accounting Concepts No. 8*, page 19, http://www.fasb.org/cs/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1175822892635&blobheader=application/pdf

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- **QC24**. Some degree of comparability is likely to be attained by satisfying the fundamental qualitative characteristics. A faithful representation of a relevant economic phenomenon should naturally possess some degree of comparability with a faithful representation of a similar relevant economic phenomenon by another reporting entity.
- **QC25**. Although a single economic phenomenon can be faithfully represented in multiple ways, permitting alternative accounting methods for the same economic phenomenon diminishes comparability.

US GAAP is an excellent financial reporting scheme because it strikes a good balance between the ability to compare and the ability to accurately report the financial condition and financial position of an economic entity. When trying to implement "comparisons" in software, it is very important to understand the goal of comparability the financial reporting scheme enables.

1.20. Conceptual Framework

The financial accounting conceptual framework created by the FASB contributes to this clear, consistent, logically coherent, and unambiguous terminology and principles by providing a disciplined framework[49] which can be used to think about financial accounting. A discussion of the conceptual framework in a FASB special report states in part the objectives of such a conceptual framework:

- Providing a set of common premises as a basis for discussion
- Provide precise terminology
- Helping to ask the right questions
- Limiting areas of judgment and discretion and excluding from consideration potential solutions that are in conflict with it
- Imposing intellectual discipline on what traditionally has been a subjective and ad hoc reasoning process

However, given the idiosyncratic tendencies of humans, interpretations which reflect the arbitrary peculiarities of individuals can sometimes slip in or mistakes can be made when expressing such terminology. Further, parts of our understanding of financial reporting can be incorrect and can evolve and improve and may even simply change over time.

Every significant financial reporting scheme such as IFRS, IPSAS, FRF for SMEs, GAS all provide conceptual frameworks for thinking about the reporting scheme.

1.21. Ledgers

Accountants have a special name for the spreadsheets, or tables, that these farmers invented. Accountants call these *ledgers*[50]. A ledger is simply a place where you record information such as transactions. There are a number of different types of ledgers that accountants use. General ledgers[51] tend to be double-entry and capture numeric information. Special ledgers, or subsidiary ledgers, are also generally

[49] Per FASB Special Report, *The Framework of Financial Accounting Concepts and Standards* (1998)
[50] Wikipedia, Ledger, https://en.wikipedia.org/wiki/Ledger
[51] Wikipedia, General Ledger, https://en.wikipedia.org/wiki/General_ledger

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double-entry and are basically special purpose ledgers for recording specific classes of transactions. 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.

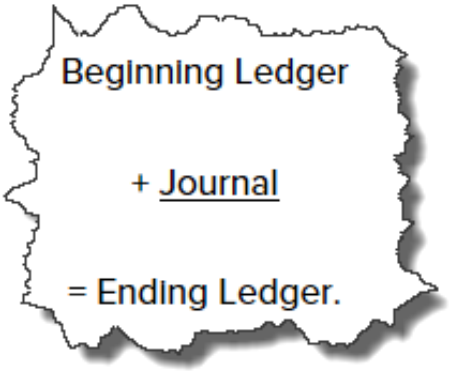
1.22. Journals

A ledger and a journal are not the same thing but are sometimes confused. Journals are the original lists of transactions. Ledgers summarize transactions, generally by account.

1.23. Ledgers and Journals, Stocks and Flows

Another important piece of double-entry accounting is explained well in David Ellerman's article, *The Math of Double-Entry Bookkeeping: Part II (vectors)*, is ledgers and journals[52].

This is the relationship between a ledger and a journal:



Ledgers summarized balances. For example, the general ledger summarizes account balances. Journals record the transactions which make up the changes between ledger balances. Other terms used for the relationship shown above are "roll forward" or "movements" or "stocks and flows". 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 which make

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

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up the roll ups of "Assets" and "Liabilities and Equity". However, there are other trees that can make up the complete "forest" of a financial report.

1.24. 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. Exactly how these line items and intermediate components (i.e. subtotals) are organized is what I call a reporting style.

1.25. Four Statement Model

Every financial reporting scheme has a characteristic that is referred to as "articulation". Articulation is the notion that the elements of a financial statement are interrelated and therefore depend on one another and so the four core financial statements; the balance sheet, the income statement, the statement of changes in equity, and the cash flow statement are all mathematically interrelated to one another. Articulation is explained very methodically by the FASB in SFAC 6[53]. The graphic below shows the interrelated nature, the articulation, of the core four financial statements:

[53] ibid, page 21 – 22, "Interrelation of Elements-Articulation"

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Cash Flow Statement [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Cash Flow Statement [Roll Forward]	
Net Cash Flow [Roll Up]	
Net Cash Flow Operating Activities [Roll Up]	
Collection of Receivables	3,000.00
Payment of Accounts Payable	(2,000.00)
Net Cash Flow Operating Activities	1,000.00
Net Cash Flow Financing Activities [Roll Up]	
Additional Long-term Borrowings 2	6,000.00
Repayment of Long-term Borrowings 2	(1,000.00)
Net Cash Flow Financing Activities	5,000.00
Net Cash Flow Investing Activities [Roll Up]	
Capital Additions of Property, Plant and Equipment 2	(5,000.00)
Net Cash Flow Investing Activities	(5,000.00)
Net Cash Flow	1,000.00
Cash and Cash Equivalents, Beginning Balance	3,000.00
Cash and Cash Equivalents, Ending Balance	4,000.00

Balance Sheet [Abstract]	Period [Axis] 2020-12-31	2019-12-31
Balance Sheet [Abstract]		
Assets [Roll Up]		
Current Assets [Roll Up]		
Cash and Cash Equivalents	4,000.00	3,000.00
Receivables	2,000.00	1,000.00
Inventories	1,000.00	1,000.00
Current Assets	7,000.00	5,000.00
Noncurrent Assets [Roll Up]		
Property, Plant and Equipment	6,000.00	1,000.00
Noncurrent Assets	6,000.00	1,000.00
Assets	13,000.00	6,000.00
Liabilities and Equity [Roll Up]		
Liabilities [Roll Up]		
Current Liabilities [Roll Up]		
Accounts Payable	1,000.00	1,000.00
Current Liabilities	1,000.00	1,000.00
Noncurrent Liabilities [Roll Up]		
Long-term Debt	6,000.00	1,000.00
Noncurrent Liabilities	6,000.00	1,000.00
Liabilities	7,000.00	2,000.00
Equity [Roll Up]		
Retained Earnings	6,000.00	4,000.00
Equity	6,000.00	4,000.00
Liabilities and Equity	13,000.00	6,000.00

Net Income (Loss) [Roll Up]	Period [Axis] 2020-01-01 - 2020-12-31
Net Income (Loss) [Roll Up]	
Income (Loss) from Continuing Operations Before Tax [Roll Up]	
Operating Income (Loss) [Roll Up]	
Gross Profit [Roll Up]	
Sales	4,000.00
Costs of Sales	2,000.00
Gross Profit (Loss)	2,000.00
Operating Expenses [Roll Up]	
Depreciation and Amortization	.00
Operating Expenses	.00
Operating Income (Loss)	2,000.00
Nonoperating Income (Expenses)	.00
Income (Loss) from Continuing Operations Before Tax	2,000.00
Income Tax Expense (Benefit)	.00
Net Income (Loss)	2,000.00

Equity [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Equity [Roll Forward]	
Equity, Beginning Balance	4,000.00
Net Income (Loss)	2,000.00
Equity, Ending Balance	6,000.00

1.26. Forests, Trees, Branches, and Leaves

I first explained graphs, forests, trees, branches, and leaves in detail in my document *Accounting Process Automation using XBRL*[54].

A **tree**[55] is a special type of graph. A tree is what is called an undirected graph because the items in a tree are connected by exactly one path. This is important to understand because it means that trees are safer than other types of graphs which can contain cycles which generally need to be avoided because they can cause problems. For example, one type of cycle is an infinite loop.

A **forest** is a disjointed union of trees. Trees have **branches**. Trees have **leaves**.

[54] Charles Hoffman, *Accounting Process Automation Using XBRL*, page 5, http://xbrlsite.azurewebsites.net/2018/Library/AccountingProcessAutomationUsingXBRL.pdf
[55] Wikipedia, *Tree (Graph Theory)*, https://en.wikipedia.org/wiki/Tree_(graph_theory)

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A chart of accounts will not have an account or ledger for either "Assets" or "Liabilities and Equity". "Assets" and "Liabilities and Equity" are branches. They are subtotals; they are intermediate components.

For example, note the branches and leaves in this tree:

- ***Assets***
    - ***Current assets***
        - **Cash and cash equivalents**
            - Cash in bank
            - Petty cash
            - Other cash and cash equivalents
        - **Receivables**
            - Trade accounts receivable
        - **Inventories**
            - Finished goods inventory
            - Work-in-progress inventory
            - Raw materials inventory
    - ***Noncurrent assets***
        - **Property, plant and equipment**
            - Land
            - Buildings
            - Equipment
        - **Long-term investments**
            - Equity securities
            - Debt securities

The items above in bold italics are branches in the tree of assets. "Assets" is the root branch. "Current assets" and "Noncurrent assets" are always branches, you never post transactions to those, they are not accounts and they don't have ledgers. Depending upon how a chart of accounts is set up something could be a branch or it could be a leaf. For example, in the example above, "Cash and cash equivalents" is likely a branch with three leaves for the accounts to which transactions are posted.

1.27. Reporting Styles

How the "branches" are organized within the "tree" of information into which the "leaves" from the chart of accounts are put is referred to as a reporting style. US GAAP has a set of reporting styles[56]. Similarly, IFRS has a set of reporting styles[57]. The same sort of pattern exists for every financial reporting scheme.

[56] US GAAP Reporting Styles, http://www.xbrlsite.com/2018/10K/US-GAAP-Reporting-Styles.pdf
[57] IFRS Reporting Styles, http://www.xbrlsite.com/2018/IFRS/IFRS-Reporting-Styles.pdf

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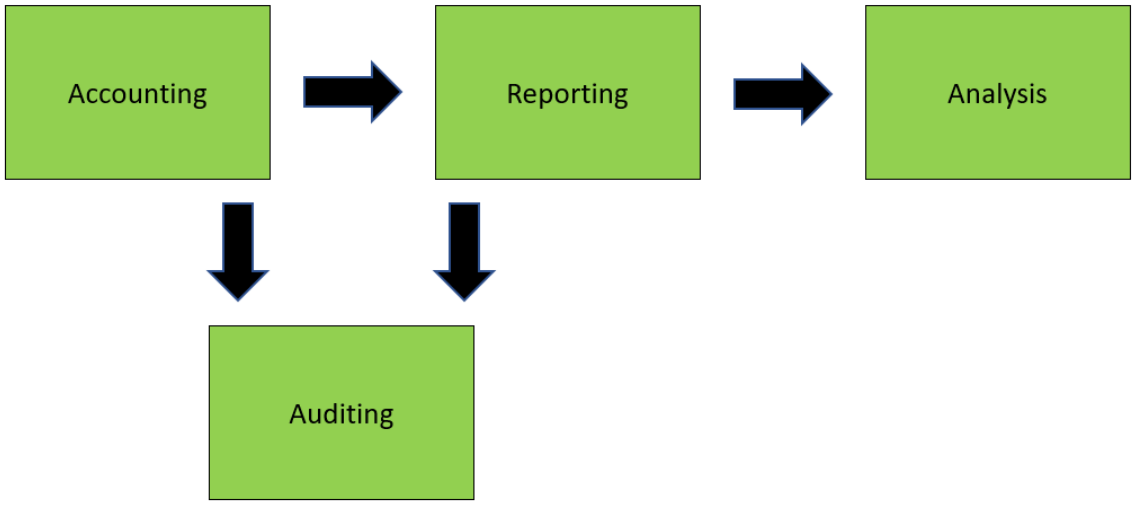
1.28. Record to Report

Wikipedia describes record to report as follows: "Record to report or R2R is a Finance and Accounting (F&A) management process which involves collecting, processing and delivering relevant, timely and accurate information used for providing strategic, financial and operational feedback to understand how a business is performing.[58]"

Another description of record to report is provided as follows[59]:

"Record to Report (R2R) is a Finance and Accounting (F&A) management process which involves collecting, processing and delivering relevant, timely and accurate information. It provides strategic, financial and operational feedback on how a business is performing. Stakeholders read the feedback and gain insights into whether an organization is performing successfully or not, and if their expectations have been met." The same author describes best practices in record to report[60].

The essence of what I call enhanced record to report can be explained graphically as follows:



- **Accounting**: Accounting information is captured in journals and ultimately posted to ledgers. Special journals may be used to feed the general ledger for specific accounting subsystems.
- **Reporting**: Accounting information is summarized and a specific generally accepted financial reporting scheme is used to report economic entity information to regulators and other appropriate parties. A special purpose financial reporting scheme might also be used sometimes.
- **Auditing**: At times, independent third-party verification is required. When required, an independent public accountant verifies that a financial report is a

[58] Wikipedia, *Record to Report*, https://en.wikipedia.org/wiki/Record_to_report
[59] Senthil Kumaran, Operations Manager - Finance and Accounting, Invensis Technologies, *What is Record to Report (R2R)*, https://www.invensis.net/blog/finance-and-accounting/what-is-record-to-report/
[60] Senthil Kumaran, Operations Manager - Finance and Accounting, Invensis Technologies, *6 Best Practices for Record-to-Report Process*, https://www.invensis.net/blog/finance-and-accounting/6-best-practices-record-report-process/

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true and fair representation of the financial position and financial performance of an economic entity.

- **Analysis**: Regulators, investors, analysts, and other such interested parties use reported information to evaluate an economic entity. Period comparisons are often created to evaluate the condition and performance of one economic entity over a period of time. Entity comparisons[61] are often created to compare and contrast one economic entity with one or more other economic entities. Financial ratios are often computed based on reported information. Financial models, such as an unlevered discounted cash flow model[62], might be created to evaluate an economic entity.

Again, this is a high-level overview of the very basics of a record to report process. In the real world, economic entities have to deal with complexities such as multiple currencies, consolidating hundreds of subsidiaries which might use different accounting systems, and other such realities.

1.29. Friction

What gets in the way of automating the record to report process? What causes "friction" in terms of human intervention to make this process either more difficult or impossible to automate?

- Inappropriately set up chart of accounts.
- Inappropriate mapping between chart of accounts and financial report line items. (i.e. lead schedules)
- Information (metadata) used to correctly categorize report information missing from the accounting system therefore automation is impossible.
- Information that is unavailable to automated processes. (i.e. policies not in accounting system, qualitative disclosures not in accounting system)
- Errors.
- Complexity. (i.e. multi-currency, multi-gaap, multi-subsidiaries, multi-special ledgers, multiple accounting systems, etc.)

One way to overcome "friction" is to through human effort at the symptoms of the problem, humans intervening to make modifications to turn an improper result into a proper result.

Another approach is to remove the friction by fixing the system. Lean Six Sigma[63] techniques and philosophies help understand how to fix the system rather than to work around problems.

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[61] Charles Hoffman, CPA, *Reporting Style Examples*, http://www.xbrlsite.com/2016/fac/v3/Examples/Index.html

[62] Charles Hoffman, CPA, *Representing Unlevered Discounted Cash Flow Model Using XBRL*, http://xbrl.squarespace.com/journal/2018/9/4/representing-unlevered-discounted-cash-flow-model-using-xbrl.html

[63] Charles Hoffman, CPA, *Lean Six Sigma*, http://www.xbrlsite.com/mastering/Part01_Chapter02.K_LeanSixSigma.pdf

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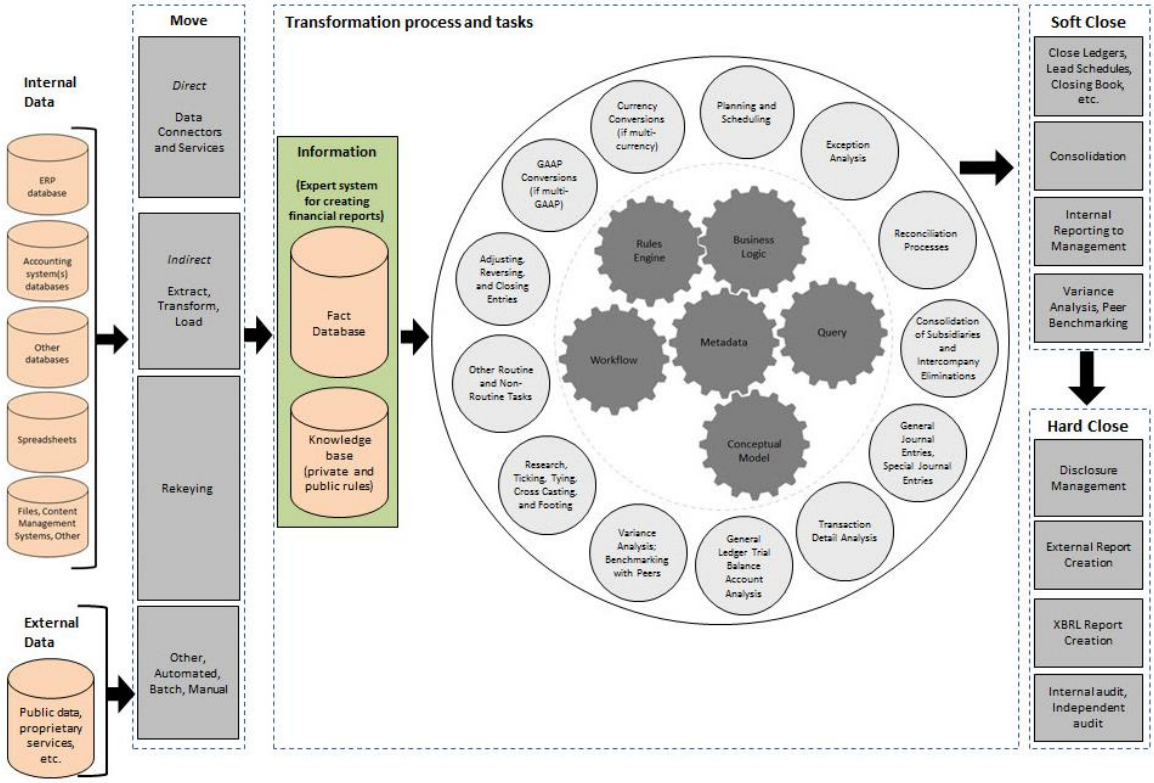
1.30. Complexity

The following graphic shows the common processes and tasks involved in the creation of general purpose or special purpose financial report:



Complexity enters this system in many ways including multiple currencies, multiple subsidiaries, multiple accounting information systems, multiple business activities, etc.

1.31. Cost of Quality

The 1-10-100 Rule is related to what's called "the cost of quality." Essentially, the rule states that prevention is less costly than correction which is less costly than failure. Saying this another way; it makes more sense to invest $1 in *prevention*, than to spend $10 on *correction*. That in turn makes more sense than to incur the cost of a $100 *failure*[64]. This 1-10-100 rule is depicted graphically as follows[65]:

[64] Michael Canic, *The Cost of Quality: The 1-10-100 Rule*, https://www.makingstrategyhappen.com/the-cost-of-quality-the-1-10-100-rule/
[65] Total Quality Management, *What is 1-10-100 Rule?*, https://totalqualitymanagement.wordpress.com/2009/02/25/what-is-1-10-100-rule/

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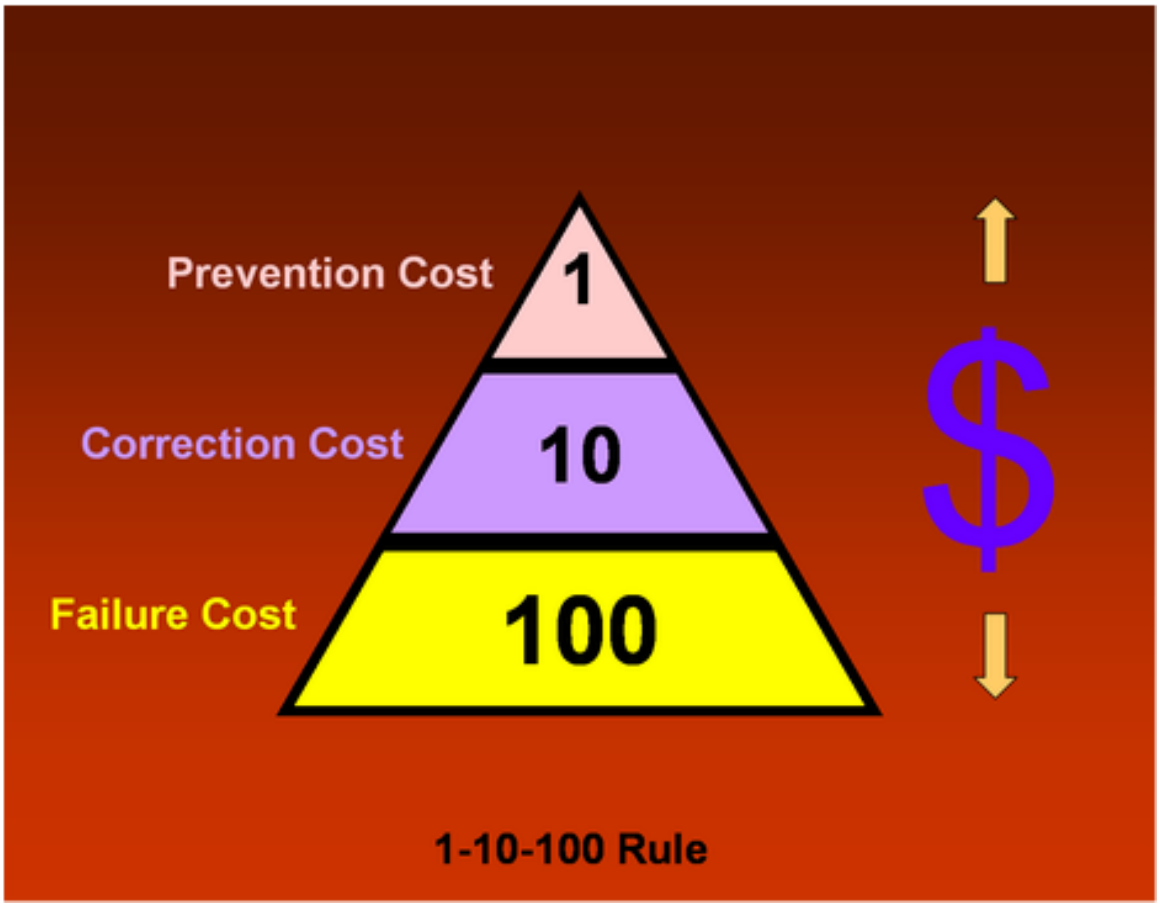

1.32. Defining quality

There are many different ways to define or think about quality. Engineer and statistician W. Edwards Deming[66] defined quality as "predictability," and called variance "the enemy of quality." To achieve an intended outcome, Deming thought it was important to plan for common-cause variation, which can be predicted, and special-cause variation, which cannot be predicted.

Harold F. Dodge, one of the principal architects of the science of statistical quality control said, "You cannot inspect quality into a product." In other words, once the inspection takes place, it's too late. Rather, data from the quality inspection needs to be utilized to continually improve the process.

Businessman Philip B. Crosby, who developed the concept of Zero Defects while working as senior quality engineer at aircraft manufacturer The Martin Company, defined quality as "a conformance to requirements." He warned against the high cost of nonconformance and said that the desired performance standard of zero defects could only be achieved through the proper management system.

Management consultant Joseph Juran, who focused on management training and the human element of quality control for a variety of businesses, stated that quality is "a fitness for use."

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[66] YouTube.com, *A Theory of a System for Educators and Managers*, https://www.youtube.com/watch?v=2MJ3lGJ4OFo

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1.33. Controlling Quality

Lean Six Sigma[67] is a discipline that combines the problem-solving methodologies and quality enhancement techniques of Six Sigma[68] with the process improvement tools and efficiency concepts of Lean Manufacturing[69]. Born in the manufacturing sector, Lean Six Sigma[70] works to produce products and services in a way that meets consumer demand without creating wasted time, money and resources.

Specifically, Lean is 'the purposeful elimination of wasteful activities.' It focuses on making process throughout your company faster, which effects production over a period of time. Six Sigma works to develop a measurable process that is nearly flawless in terms of defects, while improving quality and removing as much variation as possible from the system.

Manual approaches, automated approaches, or a combination of both manual and automated approaches can be used to control quality.

1.34. Best Practice

A **best practice** is a method or technique that has been generally accepted as superior to any alternatives because it produces results that are superior to those achieved by other means or because it has become a standard way of doing things, e.g., a standard way of complying with legal or ethical requirements.

1.35. Explanation of a Logical Theory in Simple Terms

In order to understand a logical theory, we must first explain the terms we will be using to describe that logical theory. This section provides that explanation in simple terms that is approachable to business professionals.

1.35.1. System

A system[71] is a cohesive conglomeration of interrelated and interdependent parts that is either natural or man-made.

1.35.2. Patterns

All systems exhibit patterns. A pattern[72] is any form of correlation between the states of elements within a system. The opposite of pattern is randomness.

1.35.3. Logic

Logic is thinking according to a set of consistent and coherence rules.

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[67] Wikipedia, *Lean Six Sigma*, https://en.wikipedia.org/wiki/Lean_Six_Sigma
[68] Wikipedia, *Six Sigma*, https://en.wikipedia.org/wiki/Six_Sigma
[69] Wikipedia, *Lean Manufacturing*, https://en.wikipedia.org/wiki/Lean_manufacturing
[70] Charles Hoffman, CPA and Rene van Egmond, *Comprehensive Introduction to Lean Six Sigma*, http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.72_LeanSixSigma.pdf
[71] Wikipedia, *Systems Theory*, https://en.wikipedia.org/wiki/Systems_theory
[72] YouTube.com, *The Science of Patterns*, https://www.youtube.com/watch?v=kh6KMW8J3RQ

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1.35.4. Theory

A system can be explained by a theory. A logical theory is an abstract conceptualization[73] of specific details of some domain. The logical theory provides a way of thinking about a domain by means of deductive reasoning to derive logical consequences of the theory.

A **logical theory** enables a community of stakeholders trying to achieve a specific goal or objective or a range of goals/objectives to agree on important statements used for capturing meaning or representing a shared understanding of and knowledge in some universe of discourse.

A logical theory is made up of a set of *models*, *structures*, *terms*, *associations*, *rules*, and *facts*. In very simple terms,

- **Logical theory**: A *logical theory* is a set of models that are consistent with and permissible per that logical theory.
- **Model**: A *model*[74] is a set of structures that are consistent with and permissible interpretations of that model.
- **Structure**: A *structure* is a set of statements which describe the structure.
- **Statement**: A statement is a proposition, claim, assertion, belief, idea, or fact about or related to the universe of discourse to which the logical theory relates. There are four broad categories of statements:
    - **Terms**: Terms are statements that define ideas used by the logical theory such as "assets", "liabilities", "equity", and "balance sheet".
    - **Associations**: Associations are statements that describe permissible interrelationships between the terms such as "assets is part-of the balance sheet" or "operating expenses is a type-of expense" or "assets = liabilities + equity" or "an asset is a 'debit' and is 'as of' a specific point in time and is always a monetary numeric value".
    - **Rules**: Rules are statements that describe what tend to be IF…THEN…ELSE types of relationships such as "IF the economic entity is a not-for-profit THEN net assets = assets - liabilities; ELSE assets = liabilities + equity".
    - **Facts**: Facts are statements about the numbers and words that are provided by an economic entity within a business report. For example, the financial report, a type of business report, might state "assets for the consolidated legal entity Microsoft as of June 20, 2017 was $241,086,000,000 expressed in US dollars and rounded to the nearest millions of dollars.

Fundamentally, a logical theory is a set of statements. Those statements can be represented in human-readable for or they could be expressed in machine-readable form. Once in machine-readable form, those statements can be interrogated using software applications. To the extent that this can be done effectively; software tools can assist professional accountants and others working with those statements.

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[73] Wikipedia, *Conceptual Model*, https://en.wikipedia.org/wiki/Conceptual_model
[74] Wikipedia, *Model Theory*, https://en.wikipedia.org/wiki/Model_theory

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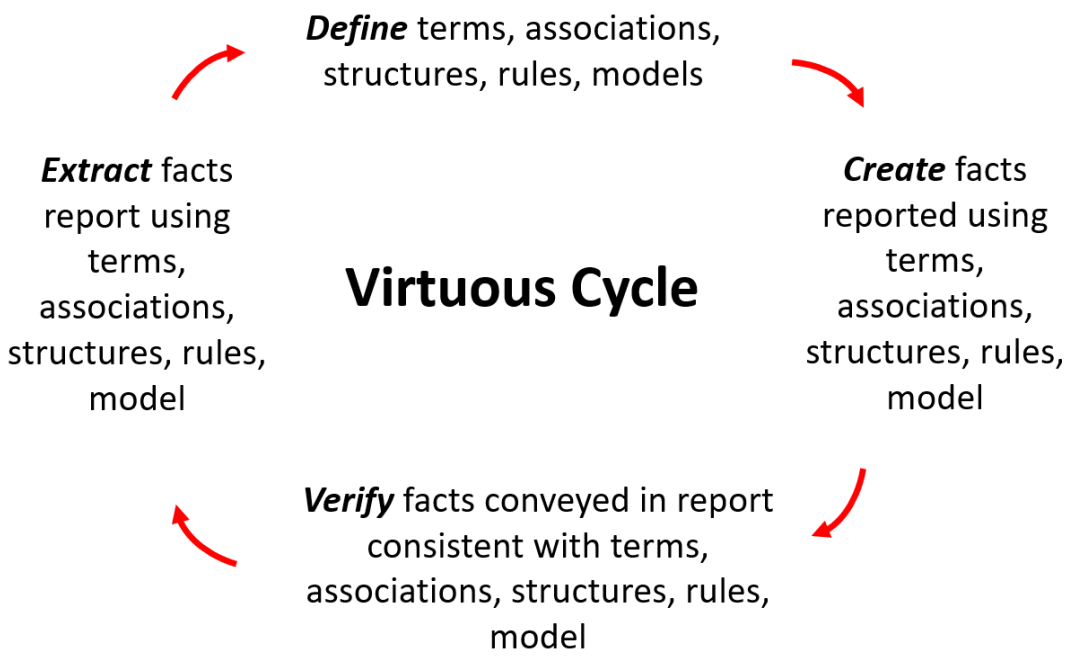
1.36. Proper Functioning Logical System

A logical theory is said to be **consistent** if there are no contradictions with respect to the statements made by the logical theory that describes the logical system (i.e. reality).

A logical theory can have high to low **precision** and high to low **coverage**. *Precision* is a measure of how precisely the information within a logical theory has been represented as contrast to reality of the logical system for the universe of discourse. *Coverage* is a measure of how completely information in a logical theory has been represented relative to the reality of the logical system for a universe of discourse.

When a logical system is consistent and it has high precision and high coverage the logical system can be considered a properly functioning logical system. When a system is working right, it creates a virtuous cycle[75].



1.37. Spectrum for Knowledge Representation and Reasoning Capabilities

The following graphic shows the relationship between knowledge representation capabilities and reasoning capabilities of a machine-based system[76] :

[75] Charles Hoffman, CPA, *Virtuous Cycle*, http://xbrl.squarespace.com/journal/2020/4/29/virtuous-cycle.html

[76] Charles Hoffman, CPA, *Revisiting the Knowledge Representation Spectrum*, http://xbrl.squarespace.com/journal/2019/10/9/revisiting-the-knowledge-representation-spectrum.html

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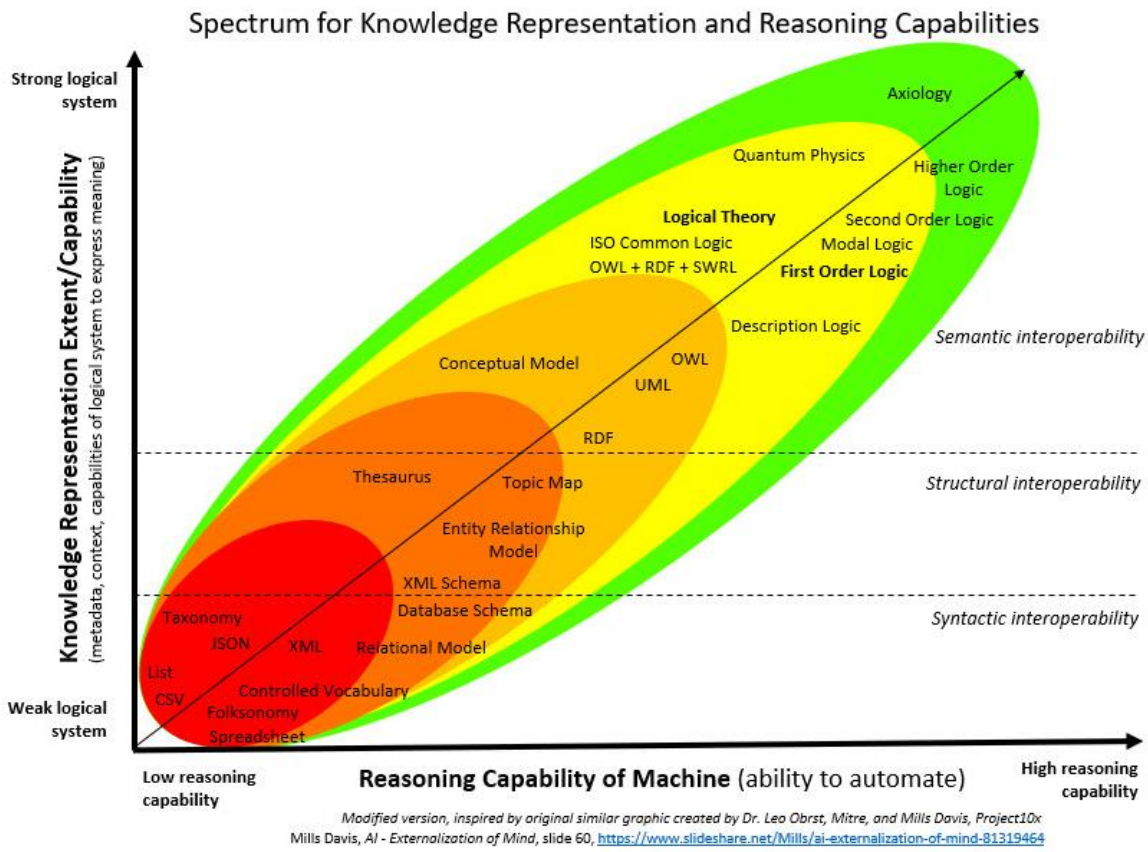

1.38. Logical Theory Describing Financial Report

Several years ago Rene van Egmond and I summarized our thoughts about the business logic of a financial report and define a conceptual model of such reports in the document *Financial Report Semantics and Dynamics Theory*[77]. Over a period of years since that document was first created, I have created various logical conceptualizations of a financial report based on XBRL-based financial reports that have been submitted to the Securities and Exchange Commission (SEC) using the US GAAP and IFRS financial reporting schemes.

While US GAAP XBRL-based reports of about 6,000 public companies have been the primary focus for about five years[78], IFRS reports of about 406 foreign issuers have also been tested[79].

The initial logical conceptualization and conceptual model has been combined into what I call the *Logical Theory Describing Financial Report*[80].

---

[77] Charles Hoffman and Rene van Egmond, *Financial Report Semantics and Dynamics Theory*, http://xbrlsite.azurewebsites.net/2016/Library/Theory-2017-06-26.pdf

[78] US GAAP Test Data - 2017 10-Ks, http://xbrl.squarespace.com/journal/2018/7/28/us-gaap-test-data-2017-10-ks.html

[79] Updated List of IFRS Filings, http://xbrl.squarespace.com/journal/2018/7/14/updated-list-of-ifrs-filings.html

[80] Charles Hoffman, CPA, *Logical Theory Describing Financial Report*, http://www.xbrlsite.com/2020/Theory/Home.html

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That logical theory has been rigorously and methodically tested[81]. The logical theory is the basis for a forthcoming OMG Standard Business Report Model (SBRM)[82]. OMG is stripping off all financial reporting related artifacts and creating a business report model.

Finally, I have taken all of this information and created a robust representation of the US not-for-profit financial reporting scheme and several reports to prototype this logical theory[83].

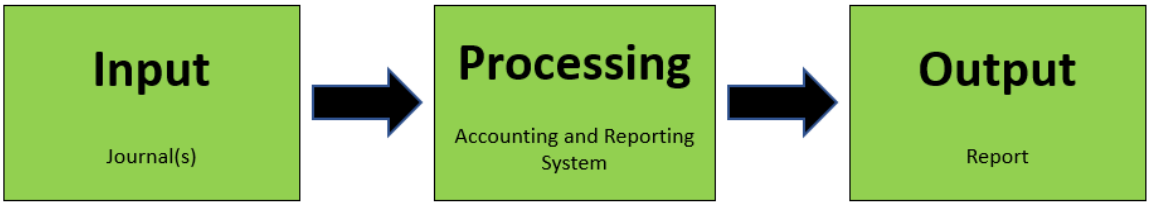
The machine-readable syntax is pure global standard XBRL.

All of this has been tested using multiple interoperable software implementations. I have created a report, taxonomy, and all the business rules necessary to provide robust verification to make sure the report is created correctly[84]. That example works as expected and proves these ideas in the Pesseract working proof of concept[85] and in commercial software that is made available in XBRL Cloud's Evidence Package[86] which is part of their Clean Score product.

Both the Pesseract and XBRL Cloud software has contributed to significant improvements in the high-level fundamental accounting concept relations of XBRL-based reports that are submitted to the U.S. SEC[87]. To a lesser extent, disclosure mechanics quality has improved and quality related to the automated reporting checklist has shown improvement.

1.39. Distilling and Making Tangible the Essence of Accounting

In its simplest form, an accounting and reporting system has three distinct parts: inputs, processing, and outputs.



Everything else is details.

In this section we try and make the details of this process as tangible and as condensed as possible. For additional details, please see *Understanding Digital*[88]

---

[81] Charles Hoffman, CPA, *Mastering XBRL-based Digital Financial Reporting*, http://xbrlsite.azurewebsites.net/2020/master/
[82] OMG, *Standard Business Report Model (SBRM)*, https://www.omg.org/intro/SBRM.pdf
[83] Charles Hoffman, CPA, Not-for-Profit Financial Reporting Scheme, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/nfp/documentation/Index.html
[84] You can download the ZIP file here, http://xbrlsite.azurewebsites.net/2018/Pesseract/DynamicRules_AllFilesLocal.zip
[85] Understanding Digital Financial Reporting Using Pesseract, http://xbrl.squarespace.com/journal/2018/10/14/understanding-digital-financial-reporting-using-pesseract.html
[86] XBRL Cloud, Clean Score, https://www.xbrlcloud.com/cleanscore.html
[87] Quarterly XBRL-based Public Company Financial Report Quality Measurement (Mar 2018), http://xbrl.squarespace.com/journal/2018/4/1/quarterly-xbrl-based-public-company-financial-report-quality.html
[88] Understanding Digital, http://xbrlsite.azurewebsites.net/2020/Library/UnderstandingDigital.pdf

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which is part of the *XBRL-based Digital Financial Reporting Jumpstart*[89]. We try and balance between providing too much and too little information. We want you to understand how this all works.

1.39.1. It's Math, It's a Knowledge Graph

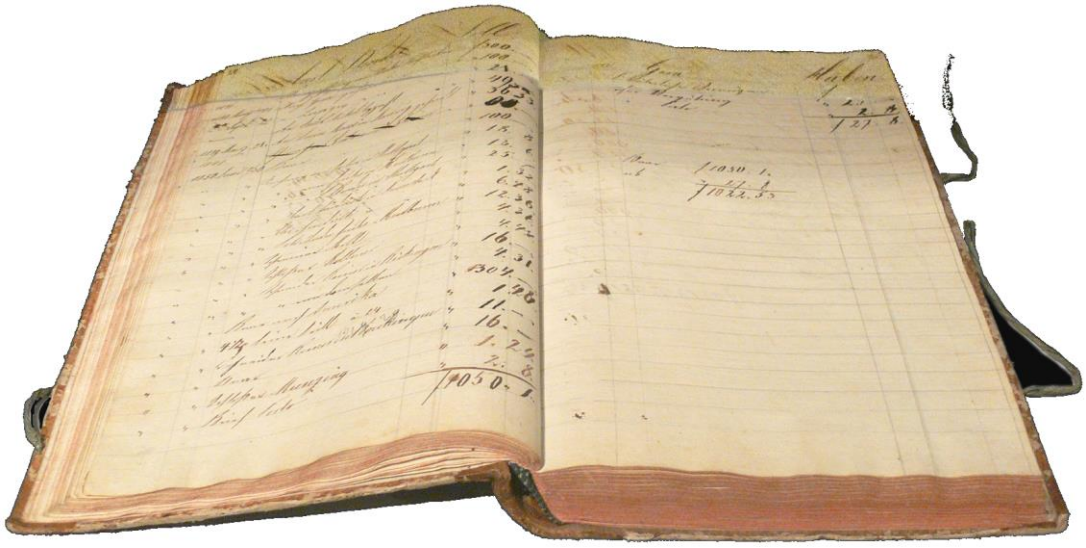
Mathematics Magazine published an article written by David Ellerman, *The Mathematics of Double Entry Bookkeeping*[90], where Ellerman points out that double entry accounting is based on well-known mathematics construction from undergraduate algebra. But Ellerman laments, "Mathematics and accounting truly seem to live in disjoint universes with no trespassing between them."

This fundamental mathematical nature of double entry accounting offers leverage when creating software. To a computer scientist, accounting is essentially a graph[91]. Accounts are nodes; transactions are edges.

Information relating to transactions, events, circumstances and other economic phenomenon related to an economic entity are entered into journals. Financial reports provide information in the form of words and numbers about the status and performance of that economic entity.

1.39.2. Augmenting Humans

One approach to instantiating such an accounting information system is using paper *journal*, having a human *process* the information in the journals, turning the journal entries into a *report*. An example of such a system is this 19th century German ledger[92]:



[89] XBRL-based Digital Financial Reporting Jumpstart, http://xbrl.squarespace.com/journal/2020/8/6/xbrl-based-digital-financial-reporting-jump-start.html
[90] David P. Ellerman, *The Mathematics of Double Entry Bookkeeping*, http://www.ellerman.org/wp-content/uploads/2012/12/DEB-Math-Mag.CV_.pdf
[91] Martin Kleppmann, *Accounting for Computer Scientists*, http://martin.kleppmann.com/2011/03/07/accounting-for-computer-scientists.html
[92] Wikipedia, *Accounting Information System*, https://en.wikipedia.org/wiki/Accounting_information_system

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Another approach is to instantiating such an accounting information system is using a computer readable journal, have a computer software application process the journals, turning the machine-readable journal entries into a report. An example of such a system is hledger[93]:

```
; $HOME/.hledger.journal (or $LEDGER_FILE)

2020-01-01 opening balances
    assets:checking         $1234
    equity

2020-03-15 client payment
    assets:checking         $2000
    income:consulting

2020-03-20 Sprouts
    expenses:food:groceries  $100
    assets:cash               $40
    assets:checking
```

```
$ hledger bs
Balance Sheet 2020-03-20

              || 2020-03-20
==============++============
 Assets       ||
--------------++------------
 assets       ||      $3134
   cash       ||        $40
   checking   ||      $3094
--------------++------------
              ||      $3134
==============++============
 Liabilities  ||
--------------++------------
--------------++------------
              ||
==============++============
 Net:         ||      $3134

$ hledger is -M
Income Statement 2020-01-01-2020-03-20

                          || Jan  Feb    Mar
==========================++=================
 Revenues                 ||
--------------------------++-----------------
 income:consulting        ||   0    0  $2000
--------------------------++-----------------
                          ||   0    0  $2000
==========================++=================
 Expenses                 ||
--------------------------++-----------------
 expenses:food:groceries  ||   0    0   $100
--------------------------++-----------------
                          ||   0    0   $100
==========================++=================
 Net:                     ||   0    0  $1900
```

hledger is a port/branch of another similar computer software application called Ledger[94]. Both hledger and Ledger are part of the plain text accounting movement[95].

I will use hledger and Ledger to help explain the essence of accounting. Several weeks ago, I created an accounting process automation and record to report demonstration[96]. That demonstration was explained in this video, Seeing XBRL Work[97]. In that demonstration, I showed a set of accounting transactions going from

[93] hledger.org, hledger, https://hledger.org/
[94] Ledger, https://www.ledger-cli.org/index.html
[95] Charles Hoffman, CPA, Plain Text Accounting, http://xbrl.squarespace.com/journal/2020/5/5/plain-text-accounting.html
[96] Accounting Process Automation, http://xbrlsite.azurewebsites.net/2020/master/automation/index.html
[97] YouTube.com, Seeing XBRL Work, https://youtu.be/xWOvwUyMZ28

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the input process (journal) to the output process (report). The processing was achieved using a Microsoft Access Database application that I created and several XBRL tools to verify the XBRL technical syntax and the accounting and reporting logic of the report.

To that prior demonstration I am adding an accounting system to verify that the information in the journal is correct as contrast to me manually verifying the journal entries. Further, I am going to explain complexities and show how those complexities fit into this basic accounting system.

1.39.3. Facts

Facts are statements about the numbers and words that are provided by an economic entity within a financial report. For example, the financial report might state "assets for the consolidated legal entity Microsoft as of June 20, 2017 was $241,086,000,000 expressed in US dollars and rounded to the nearest millions of dollars."

Words and numbers are used to convey information about the status and performance of an economic entity.

Accountants creating financial reports provide both quantitative information and qualitative information to convey the financial status and performance of an economic entity.

Quantitative information includes actual numbers to disclose an amount or to show a change. For example, "net income for the year was $1,000,000" is quantitative information.

Qualitative information includes providing information in other ways such as using relative terms. For example, disclosing an entity's objective for holding or issuing derivative instruments, background information necessary for understanding those instruments, strategies used to meet those objectives, and information helpful in understanding derivative activity is qualitative information.

1.39.4. Journal

Facts related to transactions, events, circumstances, and other economic phenomenon pertaining to an economic entity are recorded in journals.

In my prior accounting process automation example, I provided a journal represented using the XBRL Global Ledger technical syntax[98].

Those same transactions were also represented using XBRL Dimensions technical syntax[99]. For this implementation I used typed dimensions.

To those first two examples, I added the same journal entries using the plain text accounting journal format[100].

---

[98] Accounting Process Automation, *XBRL Global Ledger Format*, http://xbrlsite.azurewebsites.net/2020/master/automation/xbrl-gl-JournalEntries-Instance.xml

[99] Accounting Process Automation, *XBRL dimensions technical syntax*, http://xbrlsite.azurewebsites.net/2020/master/automation/xbrl-typedMembers-JournalEntries-Instance.xml

[100] Accounting Process Automation, Plain Text Accounting Journal Format, http://xbrlsite.azurewebsites.net/2020/master/automation/TrialBalance.dat.txt

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Further, to better document the entries I added a PDF of a printout of the details of the journal entries[101] and a screen shot of the database table which contains the journal entries itself[102].

What is interesting is that you can then run the journal entries through hledger which summarizes the transactions into the form of a basic balance sheet, income statement, and cash flow statement.

Here you see my first attempt at generating a balance sheet, income statement, and cash flow statement: (I don't have all of these correct yet; have not done the closing entries)

```
C:\Programs\hledger>hledger balancesheetequity
Balance Sheet With Equity 2020-01-01

                                || 2020-01-01
================================++============
 Assets                         ||
--------------------------------++------------
 Assets                         ||     $24000
   tb_CashAndCashEquivalents    ||      $5000
   tb_Inventories               ||      $1000
   tb_PropertyPlantAndEquipment ||     $11000
   tb_Receivables               ||      $7000
--------------------------------++------------
                                ||     $24000
================================++============
 Liabilities                    ||
--------------------------------++------------
 Liabilities                    ||     $12000
   tb_AccountsPayable           ||      $1000
   tb_LongtermDebt              ||     $11000
--------------------------------++------------
                                ||     $12000
================================++============
 Equity                         ||
--------------------------------++------------
 Equity                         ||      $6000
   tb_RetainedEarnings          ||      $4000
   tb_RetainedEarnings $-2000   ||      $2000
--------------------------------++------------
                                ||      $6000
================================++============
 Net:                           ||      $6000
```

[101] Accounting Process Automation, *Human Readable PDF of journal entries*, http://xbrlsite.azurewebsites.net/2020/master/automation/rptGeneralJournalByEntry.pdf

[102] Accounting Process Automation, *Human Readable JPEG of the database table containing the journal entries*, http://xbrlsite.azurewebsites.net/2020/master/automation/JournalEntriesInDatabase.jpg

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```
C:\Programs\hledger>hledger is
Income Statement 2019-12-31-2020-01-01

                          || 2019-12-31-2020-01-01
==========================++=======================
 Revenues                 ||
--------------------------++-----------------------
 Revenue:tb_Sales         ||                 $4000
--------------------------++-----------------------
                          ||                 $4000
==========================++=======================
 Expenses                 ||
--------------------------++-----------------------
 Expense:tb_CostsOfSales  ||                 $2000
--------------------------++-----------------------
                          ||                 $2000
==========================++=======================
 Net:                     ||                 $2000
```

```
C:\Programs\hledger>hledger cf
Cashflow Statement 2019-12-31-2020-01-01

                                    || 2019-12-31-2020-01-01
====================================++=======================
 Cash flows                         ||
------------------------------------++-----------------------
 Assets:tb_CashAndCashEquivalents   ||                $10000
 Assets:tb_Inventories              ||                 $3000
 Assets:tb_PropertyPlantAndEquipment ||                $6000
------------------------------------++-----------------------
                                    ||                $19000
```

1.39.5. Accounts

Journal entries relate to the economic entity being accounted for, some calendar period, and an account from the chart of accounts.

Both hledger and Ledger let you put in whatever accounts you want. You can add accounts on the fly. I was able to use XBRL element names as the account names.

What would be great is if you could constrain what accounts are used by specifying an XBRL taxonomy[103]. (Here is a human readable version[104]. Here is the master version in Excel[105].) For example, here is a not-for-profit chart of accounts that I created.

[103] Unified Chart of Accounts, XBRL, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/nfp/ucoa/ucoa.xsd
[104] Unified Chart of Accounts, Human readable, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/nfp/ucoa/ucoa_ModelStructure.html
[105] Unified Chart of Accounts, Master Excel version, https://netsuiteorg.atlassian.net/wiki/spaces/PB/pages/108729619/Unified+Chart+of+Accounts+UCOA

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Line	Label	Object Class	Period Type	Balance	Report ElementName
1	1110 - Unified Chart of Accounts	Network			http://www.xbrlsite.com/ucoa/role/UnifiedChartOfAccounts
2	Assets	Concept (Monetary)	As Of	Debit	nfp:Assets
3	Cash and Cash Equivalents	Concept (Monetary)	As Of	Debit	nfp:CashAndCashEquivalents
4	Cash in bank-operating	Concept (Monetary)	As Of	Debit	ucoa:CashInBankOperating
5	Cash in bank-payroll	Concept (Monetary)	As Of	Debit	ucoa:CashInBankPayroll
6	Petty cash	Concept (Monetary)	As Of	Debit	ucoa:PettyCash
7	Savings and short-term investments	Concept (Monetary)	As Of	Debit	ucoa:SavingsAndShortTermInvestments
8	Receivables	Concept (Monetary)	As Of	Debit	nfp:Receivables
9	Accounts receivable	Concept (Monetary)	As Of	Debit	ucoa:AccountsReceivable
10	Doubtful accounts allowance	Concept (Monetary)	As Of	Credit	ucoa:DoubtfulAccountsAllowance
11	Contributions receivable	Concept (Monetary)	As Of	Debit	ucoa:ContributionsReceivable
12	Pledges receivable	Concept (Monetary)	As Of	Debit	ucoa:PledgesReceivable
13	Doubtful pledges allowance	Concept (Monetary)	As Of	Credit	ucoa:DoubtfulPledgesAllowance
14	Discounts - long-term pledges	Concept (Monetary)	As Of	Credit	ucoa:DiscountsLongTermPledges
15	Grants receivable	Concept (Monetary)	As Of	Debit	ucoa:GrantsReceivable
16	Discounts - long-term grants	Concept (Monetary)	As Of	Credit	ucoa:DiscountsLongTermGrants
17	Other receivables	Concept (Monetary)	As Of	Debit	ucoa:OtherReceivables
18	Employee and trustee receivables	Concept (Monetary)	As Of	Debit	ucoa:EmployeeAndTrusteeReceivables
19	Notes/loans receivable	Concept (Monetary)	As Of	Debit	ucoa:NotesLoansReceivable
20	Doubtful notes/loans allowance	Concept (Monetary)	As Of	Credit	ucoa:DoubtfulNotesLoansAllowance
21	Inventories	Concept (Monetary)	As Of	Debit	nfp:Inventories
22	Inventories for sale	Concept (Monetary)	As Of	Debit	ucoa:InventoriesForSale
23	Inventories for [illegible]	Concept (Monetary)	As Of	Debit	ucoa:InventoriesForUse

If there was a way to specify which chart of accounts must be used and the reporting taxonomy plus reporting style used.

1.39.6. Trial Balance

A trial balance is simply a total of all journal entries (transactions) summarized by chart of accounts account. The sum of all transactions will always be zero:

Trial Balance [Roll Up]	Period [Axis]	
	2020-12-31	2019-12-31
Trial Balance [Roll Up]		
Cash and Cash Equivalents	4,000.00	3,000.00
Receivables	2,000.00	1,000.00
Inventories	1,000.00	1,000.00
Property, Plant and Equipment	6,000.00	1,000.00
Accounts Payable	(1,000.00)	(1,000.00)
Long-term Debt	(6,000.00)	(1,000.00)
Retained Earnings	(6,000.00)	(4,000.00)
Check Sum	.00	.00

1.39.7. Real versus Nominal (Temporary) Accounts

There are two types of accounts in a chart of accounts: **real** (or permanent) and **nominal** (or temporary).

Real account balances are not closed at the end of an accounting year; they begin each year with the ending balance of the prior year. Balance sheet accounts are real accounts.

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

1.39.8. Roll Forward of Real Accounts

A trial balance provides a summary of transactions by account. After a set of books is closed, every balance sheet account (each real account) has a set of transactions that flow through that account. Two accounts are of particular note.

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All the transactions that flow through the balance sheet account "Cash and Cash Equivalents" form the items that will appear on the cash flow statement if the direct method is used. For example:

Cash and Cash Equivalents [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Cash and Cash Equivalents [Roll Forward]	
Cash and Cash Equivalents, Beginning Balance	3,000.00
Collection of Receivables	3,000.00
Payment of Accounts Payable	(2,000.00)
Additional Long-term Borrowings 2	6,000.00
Repayment of Long-term Borrowings 2	(1,000.00)
Capital Additions of Property, Plant and Equipment 2	(5,000.00)
Cash and Cash Equivalents, Ending Balance	4,000.00

Each item in the roll forward above would be grouped on the cash flow statement using the direct method as either cash flows from operating, investing, or financing activities. The beginning and ending cash and cash equivalents balance ties the beginning balance sheet to the ending balance sheet of an accounting period.

Further, all the transactions that flow through the balance sheet account "Retained Earnings" form the items that will appear on the statement of changes in equity. For example,

Retained Earnings [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Retained Earnings [Roll Forward]	
Retained Earnings, Beginning Balance	4,000.00
Net Income (Loss)	2,000.00
Retained Earnings, Ending Balance	6,000.00

All the transactions that flow through the item "Net Income (Loss)" is the sum of all the transactions of the nominal accounts. The line item "Net Income (Loss)" ties the beginning and ending statement of changes in equity to both the balance sheet and to the income statement.

This forms the four statement model framework.

While a roll forward is not generally reported for each and every balance sheet account in a set of external financial statements; it is the case that every balance sheet account does have a roll forward of transactions which can be grouped into important financial information. For example, accounts receivable:

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Receivables [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Receivables [Roll Forward]	
Receivables, Beginning Balance	1,000.00
Sales 2	4,000.00
Collection of Receivables 2	(3,000.00)
Additions to Allowance for Bad Debts	.00
Bad Debts Written Off	.00
Receivables, Ending Balance	2,000.00

Long term debt:

Long-term Debt [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Long-term Debt [Roll Forward]	
Long-term Debt, Beginning Balance	1,000.00
Additional Long-term Borrowings	6,000.00
Repayment of Long-term Borrowings	(1,000.00)
Long-term Debt, Ending Balance	6,000.00

Finally, if you take all of the roll forward groupings of all the real accounts after the accounts have been closed for an accounting period; the total of those balance sheet real account roll forward groupings would be zero just like the general ledger trial balance:

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Changes Summary [Roll Up]	Period [Axis] 2020-01-01 - 2020-12-31
Changes Summary [Roll Up]	
Collection of Receivables	3,000.00
Payment of Accounts Payable	(2,000.00)
Additional Long-term Borrowings 2	6,000.00
Repayment of Long-term Borrowings 2	(1,000.00)
Capital Additions of Property, Plant and Equipment 2	(5,000.00)
Sales 2	4,000.00
Collection of Receivables 2	(3,000.00)
Additions to Allowance for Bad Debts	.00
Bad Debts Written Off	.00
Purchases of Inventory for Sale	2,000.00
Costs of Sales 2	(2,000.00)
Inventory Written Off	.00
Capital Additions of Property, Plant and Equipment	5,000.00
Depreciation and Amortization 2	.00
Property, Plant and Equipment Written Off	.00
Purchases of Inventory for Sale 2	(2,000.00)
Payment of Accounts Payable 2	2,000.00
Additional Long-term Borrowings	(6,000.00)
Repayment of Long-term Borrowings	1,000.00
Net Income (Loss)	(2,000.00)
Check Sum Changes	.00

Many accountants tend to not manage this information effectively and end up having to create this information at the end of an accounting cycle. However, if this information were entered at the point of transaction entry then a proper cash flow statement and statement of changes in equity can be generated along with a balance sheet and income statement.

1.40. Categories of Transactions

The roll forward of real accounts described in the last section help you recognize that there are patterns of transactions. The Joy of Accounting provides a list of these transaction patterns which they refer to as classic transactions[106]:

[106] Peter Frampton & Mark Robilliard, *The Joy of Accounting*, https://www.amazon.com/Joy-Accounting-Game-Changing-Approach-Makes/dp/1735312924/

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PART 2: CLASSIC TRANSACTIONS 91

Your Learning Journey, So Far 91
1. Borrowing Cash 94
2. Receive Invested Cash 104
3. Loan Repayment 116
4. Buying an Asset with Cash 124
5. Buying an Asset on Credit 130
6. (a) Revenue: Sale to Customer for Cash 139
6. (b) Cost of Sale Expense 143
6. (c) The Value Cycle of Business 149
7. Expense: Incurred and Paid 157
8. Revenue Earned, Cash Received Later: Sale & Cost of Sale 164
9. Cash Received Before Revenue Earned: Deferred Revenue 173
10. Account Receivable Settled 181
11. Prepay for an Expense 195
12. Cash Received Before Revenue Earned: Earning & Cost of Sale 202
13. Accrued Expense Incurred 214
14. Depreciation 224
15. Prepaid Expense: Consumed Gradually 237

In reality though, it is better to see that the patterns are in the nature of the business events[107] for which transactions are posted into an accounting system. Another approach to seeing the patterns of transactions is in the economic events described by the Resource-Event-Agent (REA) conceptual model[108].

1.40.1. Report Writer

Essentially, an XBRL taxonomy can be viewed somewhat as report writer metadata. The XBRL taxonomy specifies the high-level concepts that constitute a financial report and how those high-level concepts are organized (i.e. a reporting style) within the set of financial statements. The XBRL taxonomy also specifies the mathematical computations of the report.

The "leaves" or the items within the chart of account roll up to the "branches" which make up the subtotals and totals of a report. So, for example, on the actual report you see the line items "Cash and Cash Equivalents" and "Accounts Receivable" and "Inventories" as contrast to the more detailed items which are contained within the chart of accounts. Perhaps some other internal report shows both the higher level

[107] *Business Events Drive Transactions*, http://xbrl.squarespace.com/journal/2022/1/12/business-events-drive-accounting.html
[108] Understanding the Resource-Event-Agent (REA) Conceptual Model, http://xbrl.squarespace.com/journal/2016/9/27/understanding-the-resource-event-agent-rea-conceptual-model.html

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intermediate totals/subtotals and the chart of account items that make up those intermediate totals/subtotals.

Roll up:

Balance Sheet [Abstract]	Period [Axis]	
	2018-12-31	2017-12-31
Balance Sheet [Abstract]		
Assets [Roll Up]		
Current Assets [Roll Up]		
Cash and Cash Equivalents	4,000	3,000
Accounts Receivable	2,000	1,000
Inventories	1,000	1,000
Current Assets	7,000	5,000
Noncurrent Assets [Roll Up]		
Property, Plant, and Equpment, Net	6,000	1,000
Noncurrent Assets	6,000	1,000
Assets	13,000	6,000

XBRL calculation relations rule:

Label	Rendered		Reported	Calculated	Balance	Decimals	Message
Assets [Roll Up]							
Current Assets [Roll Up]							
Cash and Cash Equivalents	4,000	+	4,000	4,000	DR	INF	
Accounts Receivable	2,000	+	2,000	2,000	DR	INF	
Inventories	1,000	+	1,000	1,000	DR	INF	
Current Assets	7,000	+	7,000	7,000	DR	INF	OK
Noncurrent Assets [Roll Up]							
Property, Plant, and Equpment, Net	6,000	+	6,000	6,000	DR	INF	
Noncurrent Assets	6,000	+	6,000	6,000	DR	INF	OK
Assets	13,000		13,000	13,000	DR	INF	OK

The basic equation for a roll up is "A + B + *n* = Total", where some value A plus some value B plus *n* other values = the roll up total.

Roll forward:

Changes in ledger balances or the "flows" between a stock at two points in time or the equation "Beginning balance + changes = Ending Balance" is represented in the form of what accountants commonly refer to as a "roll forward" or "movements analysis". For example, the following is a basic roll forward:

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Long-term Debt [Roll Forward]	Period [Axis] 2020-01-01 - 2020-12-31
Long-term Debt [Roll Forward]	
Long-term Debt, Beginning Balance	1,000.00
Additional Long-term Borrowings	6,000.00
Repayment of Long-term Borrowings	(1,000.00)
Long-term Debt, Ending Balance	6,000.00

Adjustment:

Adjustments to a ledger balance to correct an error, the equation "Originally stated balance + Adjustments = Restated Balance". For example, the following is a basic adjustment:

Component: (Network and Table)	
Network	FA - Statement - **Changes in Equity, Prior Period Adjustments**
Table	Statement of Changes in Equity, Prior Period Adjustments [Table]

Reporting Entity [Axis]	1234567890 http://regulator.gov/id
Legal Entity [Axis]	Consolidated Entity [Member]
Reporting Scenario [Axis]	Actual [Member]
Unit [Axis]	USD

Statement of Changes in Equity, Prior Priod Adjustments [Li...	Report Date [Axis]	Period [Axis] 2010-01-01/2010-12-31
Retained Earnings (Accumulated Losses), Prior Period Adjustments [Adjustment]		
Retained Earnings (Accumulated Losses), Originally Stated	Reported as of February 22, 2010 [Member]	2,000
Retained Earnings (Accumulated Losses), Prior Period Errors	Reported as of March 18, 2011 [Member]	500 [1]
Retained Earnings (Accumulated Losses), Changes in Accounting Policies	Reported as of March 18, 2011 [Member]	(1,500) [1]
Retained Earnings (Accumulated Losses), Restated	Reported as of March 18, 2011 [Member]	1,000

Again, this shows the mathematical relations more clearly:

Label	Rendered Value	Op	Reported Value	Calculated Value	Balance	Result	Name
Statement of Changes in Equity, Prior Priod Adjustments [Line Items]							gaap:StatementChangesInEquityPriorPriodAdjustmentsLineItems
Retained Earnings (Accumulated Losses), Prior Period Adjustments [Adjustment]							gaap:RetainedEarningsAccumulatedLossesPriorPeriodAdjustmentsAdjustment
Retained Earnings (Accumulated Losses), Originally Stated	2,000	+	2,000		Credit		gaap:RetainedEarningsAccumulatedLosses
Retained Earnings (Accumulated Losses), Prior Period Errors	500	+	500		Credit		gaap:RetainedEarningsAccumulatedLossesPriorPeriodErrors
Retained Earnings (Accumulated Losses), Changes in Accounting	(1,500)	+	-1,500		Credit		gaap:RetainedEarningsAccumulatedLossesChangesInAccountingPolicies
Retained Earnings (Accumulated Losses), Restated	1,000	+	1,000	1,000	Credit	Verified	gaap:RetainedEarningsAccumulatedLosses

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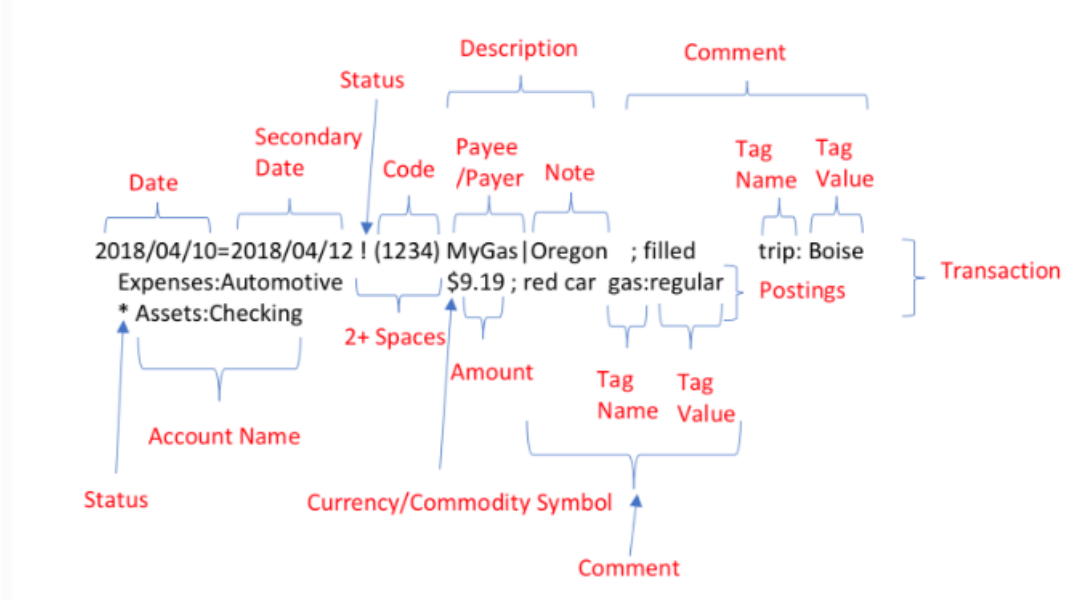
1.40.2. Metadata

Metadata[109] is simply data that provides information about other data. A chart of accounts is used to distinguish transactions that go through one account, say "Receivables", with those that go through some other account, say "Inventories". Commonly, more detail is necessary and so mechanisms exist to, say, distinguish one category of transactions related to "inventories" from another.

Different accounting systems have different mechanisms for categorizing transactions: subaccounts, additional database fields, tags, dimensions. Further, accounting systems might provide multiple mechanisms from which an accountant can choose and different accountants might make different choices. But essentially, logically the same thing is going on regardless of the means used to arrive at the fundamental objective: categorizing transactions.

XBRL also has a mechanism for distinguishing information details called XBRL Dimensions[110].

hledger and Ledger likewise have mechanisms for categorizing transactions. For example, hledger has the following mechanisms: code, description, comment, tag[111]. For example:



Fundamentally, what is going on logically is that accounting information tends to be multidimensional[112]. When you work with transactions you can work at different levels of granularity. The lowest level of granularity is typically at the accounting transaction itself. The highest level of granularity are classifications that you might find on the primary financial statements. Then, you could have multiple levels in between.

---

[109] Wikipedia, *Metadata*, https://en.wikipedia.org/wiki/Metadata
[110] XBRL International, XBRL Dimensions 1.0, http://www.xbrl.org/specification/dimensions/rec-2012-01-25/dimensions-rec-2006-09-18+corrected-errata-2012-01-25-clean.html
[111] hledger, *Tags Tutorial*, https://hledger.org/tags-tutorial.html
[112] YouTube.com, *Introduction to the Multidimensional Model for Professional Accountants*, https://youtu.be/A5AAruLUud4

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Different types of transactions have different information that might be important. For example, a job costing system needs to track each job and a fixed assets management system tracks information about individual assets. Each accounting subsystem has information that is unique to that subsystem.

But what is common to all accounting subsystems is that it is sometimes critically important to track additional details. Call the piece of information you add a "subaccount" or "dimension" or "tag" or "field" or whatever you might come up with for a name. But fundamentally, what is going on is that transactions are being provided with different information and different subsystems need different information.

1.40.3. Disclosures

Facts that flow from the double-entry accounting system to a report are not the only facts provided within a report such as an external financial report. A report also contains policies, disclosure notes, and other information that does not come from the double-entry accounting system. Commonly, that information is managed using spreadsheets, databases, and other approaches.

We described the notion of a fact ledger in the document *Introduction to the Fact Ledger*[113].

A fact ledger is a ledger in that it is used to record information. A fact ledger could be double-entry such as a general journal or a fact ledger can be single-entry and contain information that does not go through the double-entry accounting system.

The information that a fact ledger is used to record is facts. In my particular case I am interested in recording facts related to a financial report. But a fact ledger could be used to record a single fact, some set or sets of facts, or an entire database of information such as the complete set of all public company financial reports that have been submitted to a regulator such as the Securities and Exchange Commission (SEC) and placed into their EDGAR system[114]. Many different fact ledgers might be used in the process of creating a financial report.

A fact ledger is simply a standardized approach to managing the facts that make up financial report. An XBRL instance is an instantiation of a fact ledger using global standard syntax. But a collection of XBRL instances can also be a fact ledger.

Policies tend to be made up of mostly words which are not posted to a journal. Likewise, some disclosure notes likewise do not run through double-entry journals. But these policies and notes can be stored within a single-entry fact ledger. Disclosures[115], templates[116] that can be used to create disclosures, exemplars[117] or examples from other reports of the same sort of disclosure are all similar to small, machine-readable fact ledgers.

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[113] Charles Hoffman, CPA, and Andrew Noble, PNA, BBus, *Introduction to the Fact Ledger*, http://xbrlsite.azurewebsites.net/2018/Library/IntroductionToTheFactLedger.pdf
[114] XBRL Cloud, *EDGAR Dashboard*, https://edgardashboard.xbrlcloud.com/edgar-dashboard/
[115] US GAAP Disclosures, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/us-gaap/documentation/Disclosures.html
[116] US GAAP Templates, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/us-gaap/documentation/Templates.html
[117] US GAAP Examples, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/us-gaap/documentation/Examples.html

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1.40.4. Provenance

Being able to trace back to the origin of information and understand the chain of custody or who has access and could therefore manipulate information provides the possibility of establishing an audit trail.

1.40.5. Auditing

Auditors independently verify facts provided within a financial report.

The purpose of an audit is to provide an independent third-party opinion as to whether reported information about the financial condition and financial performance of an economic entity is being represented fairly by the information provided in a financial report, in all material respects. The audit is about the **independent third-party opinion** as to the fairness of that information. Financial reporting managers still need to represent information in their financial reports that reflects the true and fair status and performance of an economic entity. They may not be independent of the economic entity, but the steps used in many cases by a reporting manager and an auditor are the same.

External financial reporting managers need to create true and fair representations of their financial information. The team that works with the external financial reporting manager needs to make sure the financial report is true and fair. Internal auditors that work for a company to make sure the external financial reporting manager is doing their job correctly need to make sure the information is true and fair. Finally, the CFO that signs off on the report needs to make sure the financial report information is true and fair.

The point here is that there are lots of people who care that the information contained in a financial report is represented appropriately, not just auditors. Many of the tasks and procedures auditors use are the same tasks and procedures that an external financial reporting manager should be using. Sure, some are different. But fundamentally, the objective is to make sure information is true and fair.

1.40.6. Financial Analysis

Financial reports are created to provide information about the financial position and financial performance of regulators, investors, financial analysts, and other interested parties. Management of an economic entity is also interested in this information for the purposes of managing the economic entity. The level of detail might be different depending if a financial report is created for someone internal and someone external to the reporting economic entity.

Economic entities can use whatever organization they might choose for financial information that is consumed within that organization. However, when financial information is reported external to an economic entity and that report is required to be prepared using some specific financial reporting scheme then the rules of that financial reporting scheme must be applied to the external financial reports. External financial information can also be used for internal purposes but generally internal information is generally more detailed in nature.

Financial analysts and others create ratios[118] that are used to evaluate the information provided by an economy entity. An example of a few ratios include:

[118] Ciaran Walsh, *Key Management Ratios*, https://www.amazon.com/Key-Management-Ratios-Financial-Times/dp/0273719092

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working capital, debt to equity ratio, return on assets, return on equity, return on sales. Financial analysts created financial models such as the unlevered discounted cash flow model[119].

1.40.7. Financial Benchmarking

Economic entities and auditors tend to benchmark reported financial information against that economic entity's peers in order to search for reporting errors and to better understand reported financial information and financial trends. Because only summarized information tends to be available for peers, benchmarking tends to be at the financial report line item level.

1.40.8. Variance Analysis

Economic entities and auditors tend to analyze reported financial information against prior financial information for that economic entity to search for possible reporting errors and to better understand reported financial information and financial trends. Because all of this information is internal, variance analysis could be performed down to any level of detail.

In addition to variance from actual reported accounts, variance from budget(s) and/or any forecast(s) might also be performed if budgets and forecasts exist for an economic entity.

1.40.9. Digital Distributed Ledger

Explaining digital distributed ledgers in any detail is beyond the scope of this document; I would refer you to *Comprehensive Introduction to Digital Distributed Ledgers*[120]. There are a lot of details that still need to be worked out but digital distributed ledgers appear promising. That said, we do want to introduce the idea.

A digital distributed ledger[121] is an indestructible and un-editable decentralized computer record, or ledger. A digital distributed ledger provides a full and complete history of transactions in that ledger. Ledgers can be as public and open or private and limited as the use case demands. Ledgers can be permissioned or permission-less in determining who can add new transactions. Different approaches can be used to determine how new transactions are authorized (proof-of-stake, proof-of-work, consensus, identity mechanisms) before they can add new information to the ledger. Ledgers can be interlinked with one or more other ledgers.

The following is a summary of the characteristics of a digital distributed ledger:

- No hackers can corrupt information because there is no centralized version; there are many versions and they all must agree
- Immutable (unchangeable, secure, set in stone)
- No centralized administrator/authority owns the system

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[119] Charles Hoffman, CPA, *Representing Unlevered Discounted Cash Flow Model Using XBRL*, http://xbrl.squarespace.com/journal/2018/9/4/representing-unlevered-discounted-cash-flow-model-using-xbrl.html

[120] Charles Hoffman, CPA, *Comprehensive Introduction to Digital Distributed Ledgers*, http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.71_DistributedLedgers.pdf

[121] Wikipedia, *Distributed Ledger*, https://en.wikipedia.org/wiki/Distributed_ledger

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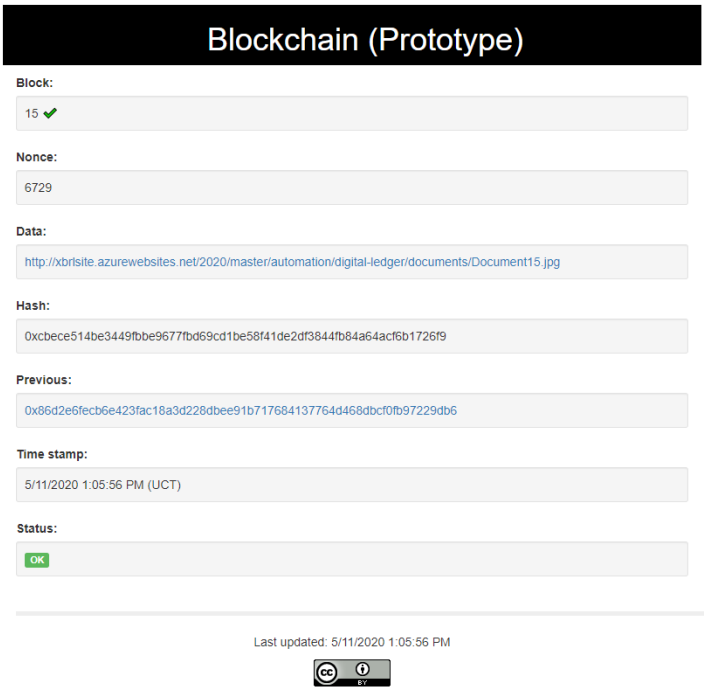
- Entries into ledger are "notarized" (similar to idea of notary public)
- Public or private; permissioned or permission-less
- Machine readable
- Stand alone or interlinked with other ledgers

The following is a prototype digital distributed ledger created so that you can get the feel of such ledgers[122]:



This[123] is a second digital distributed ledger example.

[122] Digital Distributed Ledger Prototype, http://xbrlsite.azurewebsites.net/2020/master/automation/digital-ledger/blocks/0xcbece514be3449fbbe9677fbd69cd1be58f41de2df3844fb84a64acf6b1726f9.html

[123] Second digital distributed ledger prototype, http://xbrlsite-app.azurewebsites.net/io/certification/0x000e499240f14b8b98978dc65c66aa8a441d063f106c41c88efd262dffb5404d.html

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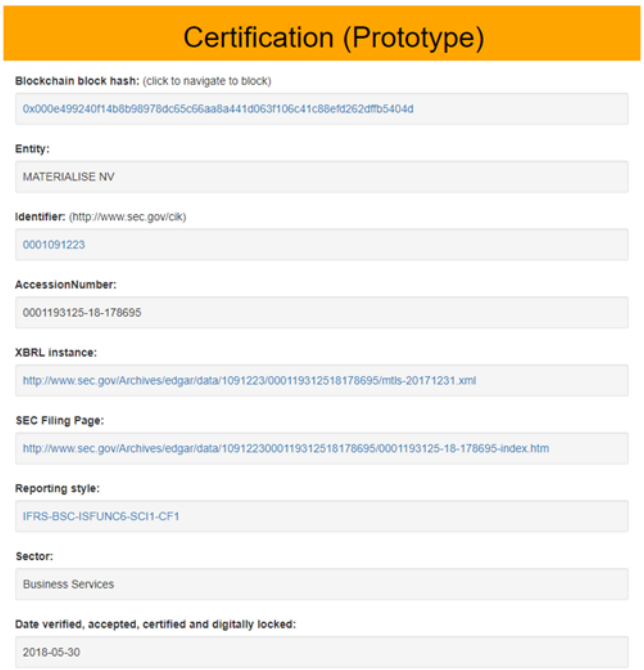

Certification (Prototype)

Blockchain block hash: (click to navigate to block)

0x000e499240f14b8b98978dc65c66aa8a441d063f106c41c88efd262dffb5404d

Entity:

MATERIALISE NV

Identifier: (http://www.sec.gov/cik)

0001091223

AccessionNumber:

0001193125-18-178695

XBRL instance:

http://www.sec.gov/Archives/edgar/data/1091223/000119312518178695/mtls-20171231.xml

SEC Filing Page:

http://www.sec.gov/Archives/edgar/data/1091223000119312518178695/0001193125-18-178695-index.htm

Reporting style:

IFRS-BSC-ISFUNC6-SCI1-CF1

Sector:

Business Services

Date verified, accepted, certified and digitally locked:

2018-05-30

1.40.10. Financial Report

The final product or output of the tasks and processes is a financial report. Information from that financial report came from an accounting information system. That report might be audited. That report might be analyzed.

The intent of this section is to explain that financial reports created using this process could look precisely like financial statements created today. Those reports, however, would be created in new ways.

As I understand it, today about 85% of external financial reports created are created using word processors and spreadsheets that have no knowledge of financial reporting. Because these applications have no knowledge of financial reporting, the burden is on the creator of the financial report, the operator of the word processing documents and spreadsheets, to understand financial reporting rules.

It is my view that some of the boring, mundane and mindless tasks involved in the creation of external financial reports can be delegated to automated machine-based processes.

The following is an example of one possible target so that you can get a feel for the quality of the financial reports that I am referring to[124]:

[124] Inline XBRL report example, http://xbrlsite.azurewebsites.net/2020/master/tb/instance-PixelPerfect.html

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Balance Sheet

ABC Company, Inc.

(See accompanying notes to the financial statements.)

(in US Dollars)	As of December 31, 2018	As of December 31, 2017
ASSETS		
Current Assets:		
Cash and cash equivalents	$4,000	$3,000
Receivables	2,000	1,000
Inventories	1,000	1,000
Current assets	7,000	5,000
Noncurrent Assets:		
Property, plant, and equipment	6,000	1,000
Noncurrent assets	6,000	1,000
Assets	$13,000	$6,000
LIABILITIES AND EQUITY		
LIABILITIES		
Current liabilities:		
Accounts payable	$1,000	$1,000
Current liabilities	1,000	1,000
Noncurrent liabilities:		
Long-term debt	6,000	1,000
Noncurrent liabilities	6,000	1,000
Liabilities	7,000	2,000
EQUITY		
Retained earnings	6,000	4,000
Equity	6,000	4,000
Liabilities and equity	$13,000	$6,000

Essentially, pixel perfect external financial reports could be created to the extent of the features of HTML 5 and CSS 3 for document publishing. Such a report could be supplemented by something like an Inline XBRL viewer software application[125].

Other rendering alternatives are available that provide far less work but the presentation formats are not pixel perfect. Specific details of a report can be

[125] Inline XBRL report with embedded viewer, http://xbrlsite.azurewebsites.net/2020/master/tb/instance-PixelPerfectWithViewer.html

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communicated precisely[126]. Entire HTML-based applications can be created for interacting with a financial report; for example[127],

Statement of Financial Postion, Classified [Line Items]	Period [Axis]	
	2020-12-31	2019-12-31
Assets [Roll Up]		
Current Assets [Roll Up]		
Cash and Cash Equivalents	25,843	29,843
Short-term Investments	17,855	17,440
Receivables	4,833	5,750
Inventories	18,751	12,144
Prepaid Expenses	1,284	1,743
Other Current Assets	3,467	2,588
Current Assets	72,033	69,508
Noncurrent Assets [Roll Up]		
Investments, Noncurrent	84,839	84,839
Property, Plant and Equipment	190,745	189,176
Other Noncurrent Assets	29,803	34,509
Noncurrent Assets	305,387	308,524
Assets	377,420	378,032

While all of these reports are readable by humans, each is also machine readable[128]. In fact, the autogenerated HTML-based reports are generated dynamically using the machine-readable XBRL-based report plus supporting XBRL taxonomies.

Taking all this a step further, machine-readable reports can be interacted with using software applications[129]. These sorts of software applications are a lot like pivot tables with all sorts of robust functionality[130].

However, there are some issues related to some autogenerated financial reports. HTML 5 and CSS 3 currently do not support page layout document oriented flow control[131]. As such, it can be challenging to get a report that works well on the web to also act well as a printed document.

---

[126] HTML-based autogenerated representation of financial report, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/nfp/reference-implementation/evidence-package/contents/RenderingSummary.html

[127] Auto-generated financial report, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/nfp/reference-implementation/evidence-package/

[128] Machine-readable raw XBRL instance, http://xbrlsite.azurewebsites.net/2020/reporting-scheme/nfp/reference-implementation/instance.xml

[129] Pesseract working proof of concept, http://pesseract.azurewebsites.net

[130] Self guided tour of XBRL-based financial report, http://xbrlsite.azurewebsites.net/2019/Tour

[131] Quark, The Ugly Duckling No More: Using Page Layout Software to Format DITA Outputs, https://blog.quark.com/2016/10/ugly-duckling-no-using-page-layout-software-format-dita-outputs/

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Document Information Typing Architecture[132] (DITA) is a step closer to better layout when page flow is desired. Another option is a word processor document format such as DocBook[133]. DITA is different than DocBook[134]. Another alternative is XSL-FO which does basic page flow but does have limitations; but it is free and can be used to generate a PDF document.

HTML and CSS are suitable and sufficient for browser-oriented rendering of information. To overcome those limitations, the W3C created the Extensible Stylesheet Language Formatting Objects (XSL-FO) to define a collection of pagination semantics for print-oriented rendering.

Exactly which of these alternatives to use for printed financial reports is up in the air. If you don't care about page flow, such as with Inline XBRL documents that are not intended to be printed, then XHTML + XBRL (i.e. Inline XBRL) could work just fine. If you want pixel-perfect rendering, commercial publishing alternatives exist but they tend to be somewhat expensive.

Serializing financial reports to OpenDocument[135] or Microsoft Word is very doable. Even better, outputting to multiple different rendering formats would also be a very good thing.

Are "pretty" financial reports necessary? Sometimes likely yes, other times perhaps not.

1.41. Repeatable Method

I have published a number of documents trying to show and explain the process of creating a financial report. This is a summary of information from those documents and what I was trying to achieve with the document. Right now, I can say that I do have a method for creating high-quality XBRL-based digital financial reports. I cannot say that I have adequately documented this best practices-based method yet.

What I am trying to show in the document *General Ledger Trial Balance to External Financial Report*[136], is a basic example of taking the information from a general journal to a general ledger and then ultimately to a financial report using XBRL. The beginning of the process is the accounting system which summarized the information, the end of the process is a human readable and machine readable financial report.

What I was trying to show in the document *INTELLIGENT DIGITAL FINANCIAL REPORTING – PART 4: EXAMPLES AND SAMPLES – COMPREHENSIVE EXAMPLE*[137], is a much more complex financial report which was created using the same techniques

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[132] Wikipedia, *Document Information Typing Architecture*, https://en.wikipedia.org/wiki/Darwin_Information_Typing_Architecture
[133] DocBook.org, What is DocBook?, https://docbook.org/whatis
[134] DocBook versus DITA Comparison, https://www.oxygenxml.com/events/2018/DITA_OT_DAY/Radu-Coravu_docbook-vs-dita.pdf
[135] Wikipedia, *OpenDocument*, https://en.wikipedia.org/wiki/OpenDocument
[136] Charles Hoffman, CPA, *General Ledger Trial Balance to External Financial Report*, http://xbrlsite.azurewebsites.net/2018/RoboticFinance/TrialBalanceToReport.pdf
[137] Charles Hoffman, CPA and Rene van Egmond, *INTELLIGENT DIGITAL FINANCIAL REPORTING – PART 4: EXAMPLES AND SAMPLES – COMPREHENSIVE EXAMPLE*, http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part04_Chapter07.5_ComprehensiveExample.pdf

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as the basic example. Not that this document has several "forests" or disjointed unions of trees meaning that not all the information in this financial report is run through the general ledger trial balance.

What I am trying to show in the blog post *Representing Unlevered Discounted Cash Flow Model Using XBRL*[138], is both how information from a financial report is used by financial analysts to analyze economic entities reporting information and that such models can be created using techniques similar to how the financial reports themselves are created.

What I am trying to show in the document *Introducing the Fact Ledger*[139], is that intermediate documents or ledgers can be used to summarize information that is used within this process.

What I am trying to show in the document *Blueprint for Creating Zero-Defect XBRL-based Digital Financial Reports*[140]; is how business rules can be used to automate many of the tasks related to moving information from one step to another, verifying that information is correct and otherwise of high quality so that these processes can be reliable.

What we are trying to show in the document *Putting the Expertise into an XBRL-based Knowledge Based System for Creating Financial Reports*[141], are general ideas related to how patterns can be leveraged when creating software that is useful in creating XBRL-based financial reports.

Finally, what I tried to show in the document *Guide to Building an Expert System for Creating Financial Reports*[142], are specific techniques we used to create Pesseract[143] which is a working proof of concept which we used to prototype and test the ideas in this document. The application can be downloaded and used to better understand these ideas.

My next step is to turn all of this information into a documented method that is easy to understand.

1.42. Ecosystem

Imagine an ecosystem that is as elegant as an iPhone for accounting, reporting, auditing, and analysis. Imagine if standard technical syntaxes existed and you could convert bidirectionally from one syntax back to some other syntax. Imagine if the logic of accounting, reporting, auditing, and analysis was agreed to by the members

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[138] Charles Hoffman, *Representing Unlevered Discounted Cash Flow Model Using XBRL*, http://xbrl.squarespace.com/journal/2018/9/4/representing-unlevered-discounted-cash-flow-model-using-xbrl.html

[139] Charles Hoffman and Andrew Noble, *Introducing the Fact Ledger*, http://xbrlsite.azurewebsites.net/2018/Library/IntroductionToTheFactLedger.pdf

[140] Charles Hoffman, *Blueprint for Creating Zero-Defect XBRL-based Digital Financial Reports*, http://xbrlsite.azurewebsites.net/2017/Library/BlueprintForZeroDefectDigitalFinancialReports.pdf

[141] Charles Hoffman and Hamed Mousavi, *Putting the Expertise into an XBRL-based Knowledge Based System for Creating Financial Reports*, http://pesseract.azurewebsites.net/PuttingTheExpertiseIntoKnowledgeBasedSystem.pdf

[142] Charles Hoffman, *Guide to Building an Expert System for Creating Financial Reports*, http://xbrlsite.azurewebsites.net/2018/Library/GuideToBuildingAnExpertSystemForCreatingFinancialReports.pdf

[143] Pesseract, http://pesseract.azurewebsites.net/

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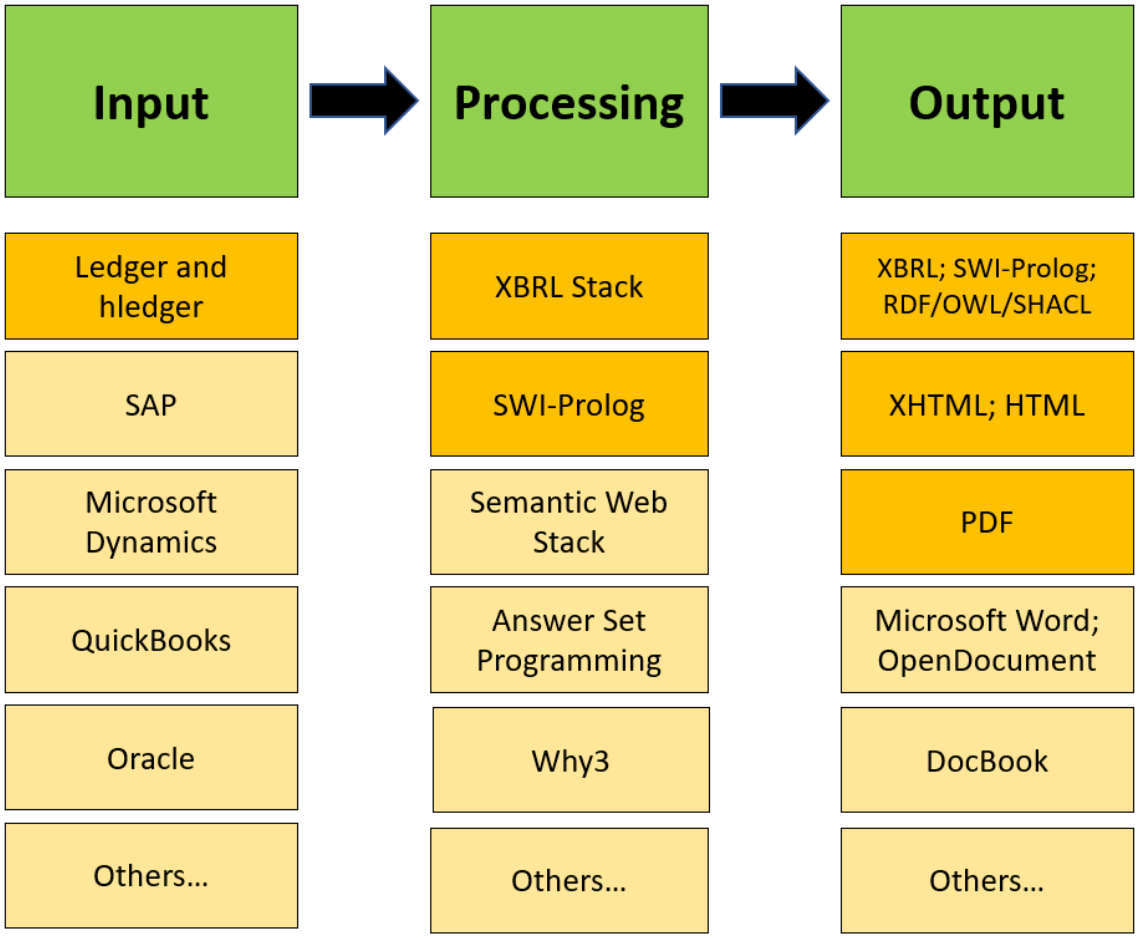
of the supply chain. Software vendors and other stakeholders could plug into this digital ecosystem and add value. Imagine if standard output formats were agreed to. Imagine something like this:



Imagine if ISO and OMG standards were leveraged similar to how the ISO standard shipping container, the Universal Product Code is leveraged in retail, or MPEG formats for movies.

Youtube.com does not support just one single technical format, it supports all of the follow following formats: MOV, MPEG4, AVI, WMV, MPEG PS, FLV, 3GPP and WebM.

Multiple technical formats are a reality.

This ecosystem already exists to a degree. The darker orange color exists and works today. The lighter color orange does not yet work. Piece-by-piece, this will ultimately be put together.

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1.43. Triple entry accounting system

The idea of triple entry accounting was first introduced by Yuji Ijiri in 1989 in his book *Momentum Accounting & Triple-Entry Bookkeeping*[144]. In 2005, cryptographer Ian Grigg provided a more well-known example of a triple-entry accounting system, in a paper, *Triple Entry Accounting*[145]. Some are saying that triple-entry accounting is the most important invention of the last 500 years[146].

With triple entry accounting, both parties to a transaction would complete a transaction and simultaneously record information about that transaction in a shared ledger such as a digital distributed ledger. Once that happens, it's necessary to ensure that that information about that transaction can't be changed.

1.44. Universal Technology for Accountability

Double entry bookkeeping is a universal technology used around the world by organizations, individuals, and communities. Regardless of the size of the organization, the location in the world, the activity of the organization, or the complexity of the organization; the double entry bookkeeping model works. Double entry bookkeeping will never become obsolete. Formally documented by Luca Pacioli in 1494 and referred to as the Venetian Method, double entry bookkeeping is a global standard.

Accounting using the double entry bookkeeping method is about documentation and accountability using a proven, professional approach that detects errors and differentiates an unintentional error from an intentional error (i.e. fraud). Without accountability civilization cannot advance. Accountability advances civilization, economics, enterprises, environmental stewardship, personal property, governmental stewardship, etc.

Accounting is one of the most important technologies invented in the history of human civilization and has been around about 7,000 years. Accounting was invented before writing and before the invention of numbers. The global multinational organization simply could not exist without double entry bookkeeping and accounting.

The simple concepts that are used to build financial accounting and financial reporting yield an elegant result.

Orthodox is defined as conforming to what is generally or traditionally accepted as right or true; established and approved. Topology is the way in which constituent parts are logically interrelated or arranged. Orthodox topologies or logical schemas of financial reports that summarize some set of accounting transactions that result from some set of business events of an economic entity can be differentiated from the unorthodox given a clear and complete set of rules.

This universal technology of accountability is grounded, even ingrained, in medieval traditions. Yet this universal technology of accountability is going to be impacted by

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[144] Yuji Ijiri, *Momentum Accounting & Triple-Entry Bookkeeping*, American Accounting Association, https://www.goodreads.com/book/show/15067963-momentum-accounting-triple-entry-bookkeeping

[145] Ian Grigg, *Triple Entry Accounting*, http://iang.org/papers/triple_entry.html

[146] Daniel Jeffries, *Why Everyone Missed the Most Important Invention in the Last 500 Years*, https://hackernoon.com/why-everyone-missed-the-most-important-invention-in-the-last-500-years-c90b0151c169

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structured information, artificial intelligence, digital distributed ledgers, and other such technologies. And they should be. Those same technologies that are causing the ever increasing volume and complexity of information that is overwhelming us is also the solution to the information overload that is being experienced.

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