1. Auditing XBRL-based Digital Financial Reports

The purpose of this section is to discuss issues related to the audit of XBRL-based digital financial reports.

A financial report is a true, faithful, allowed interpretation of an expression of the financial position and financial performance of an economic entity per some set of statutory and regulatory rules. Here-to-for, that expression has been in a form that is only readable by humans. However, XBRL and other machine-readable formats change that, making those expressions readable by both humans and by machine-based processes.

Single-entry accounting is how 'everyone' would do accounting. In fact, that is how accounting was done before double-entry accounting was invented. Double-entry accounting was the invention of medieval merchants and was first documented by the Italian mathematician and Franciscan Friar Luca Pacioli.

Double-entry accounting adds an additional important property to the accounting system, that of a clear strategy to identify errors and to remove the errors from the system. Even better, double-entry accounting has a side effect of clearly firewalling errors as either accident or fraud[1]. This then leads to an **audit strategy**. Double-entry accounting is how professional accountants do accounting.

An XBRL-based financial report is not only a machine-readable format; it also is a machine-readable logical system and has the potential to be a well-defined and fully expressed logical system. A well-defined logical system, when fully expressed, will be properly functioning and demonstrably consistent, valid, sound, and complete. These properties can be leveraged to offer a systematic **audit strategy for XBRL-based financial reports**.

Essentially, an XBRL-based financial report is a set of declarative statements provided in global standard XBRL format. Logic programming software applications such as Prolog, Datalog, Clips, and Answer Set Programming can provide feedback as to whether these statements are consistent, valid, sound, complete and otherwise properly functioning. Even XBRL processors and XBRL formula processors can effectively prove that XBRL-based financial reports are properly functioning to a large degree.

1.1. Statements

A financial report makes statements about the financial position and financial performance of an economic entity. Consider the name, "financial statements". Some of those statements might be organized into the form of a table or tabular presentation of information; for example, a balance sheet. But fundamentally, a financial report makes statements about the financial position and financial performance of an economic entity. Some statements may be quantitative in nature, other statements may be qualitative in nature.

---

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

Historically, those statements and the meaning they convey have been readable by human-based processes. With the introduction of XBRL this changes. XBRL-based financial reports are readable by both humans and by machine-based processes.

But how do professional accountants creating these reports make sure they convey the information, more make the statements, that they desire and intend to make? How does an internal auditor review such reports? How does an independent auditor confirm such reports are conveying meaning appropriately? How do financial analysts extracting and using information do so appropriately?

1.2. Current Audit Guidance

While the AICPA's *Principles and Criteria for XBRL-Formatted Information*[2] lays a good foundation for thinking about how to create XBRL-based financial reports correctly, review a report that another has created, provide attestation services related to such a report, or providing agreed-upon consulting services; the AICPA's guidance state (emphasis added):

"The quality of XBRL files is an important concern to users of these files. Errors in the XBRL files will have varying consequences. During the development of the XBRL principles and criteria, potential errors that could occur when preparing XBRL files were considered, and **it is believed** that the **criteria addresses many of these errors**. Further, the principles and criteria meet the requirements under AT section 101, as previously discussed in paragraphs .11-.13, and, thus are **considered suitable** for practitioners to perform an attestation engagement."

Hope is not a solid system engineering principle. Clearly, those creating such XBRL-based reports need to **make sure no errors exist**. Accountants and auditors cannot "*believe*" that such a report is correct using a process that "*addresses many of these errors*". Accountants and auditors need to make sure no errors exist. Two auditors looking at the same XBRL-based report should be able to reach the same conclusion about the subjective mechanical, structural, mathematical, and other logical considerations related to such reports. Without this capability, XBRL-based reports really cannot be considered reliable, yet alone auditable.

Many professional accountants and auditors do not understand how to interact with XBRL-based financial reports because they don't have important background necessary to do so[3]. Trying to understand XBRL-based financial reports using old outdated mental maps will be unsatisfying to say the least.

Two academic papers discuss how to audit XBRL-based financial reports: Srivastava, Rajendra Prasad and Kogan, Alex, *Assurance on XBRL Instance Document: A Conceptual Framework of Assertions* (September 9, 2009)[4] and J. Efrim Boritz and Won Gyun No *Computer-Assisted Functions for Auditing XBRL-Related Documents*[5].

---

[2] American Institute of Certified Public Accountants, 2017, *Principles and Criteria for XBRL-Formatted Information*,
https://www.aicpa.org/InterestAreas/FRC/AccountingFinancialReporting/XBRL/DownloadableDocuments/aicpa-principles-and-criteria-for-xbrl-formatted-information.pdf
[3] Charles Hoffman, CPA, *Artificial Intelligence and Knowledge Engineering Basics in a Nutshell*,
http://xbrlsite.azurewebsites.net/2019/Library/KnowledgeEngineeringInNutShell.pdf
[4] Srivastava, Rajendra Prasad and Kogan, Alex, *Assurance on XBRL Instance Document: A Conceptual Framework of Assertions* (September 9, 2009). Available at SSRN: https://ssrn.com/abstract=1289467
[5] J. Efrim Boritz and Won Gyun No (2016) Computer-Assisted Functions for Auditing XBRL-Related Documents. Journal of Emerging Technologies in Accounting: Spring 2016, Vol. 13, No. 1, pp. 53-83, https://www.aaapubs.org/doi/10.2308/jeta-51436

Journal of Emerging Technologies in Accounting. Both papers point to the need for a framework and methodology to audit the information contained within an XBRL-based financial report.

1.3. Myths and Misconceptions Related to the "Audit of XBRL"

There are many myths and misconceptions professional accountants, professional auditors, and others have about the "audit of XBRL".

The first misconception is that XBRL is audited at all. XBRL is a technical format. The XBRL technical format can be verified 100% by automated software tests. That is the purpose of the XBRL International XBRL conformance suite tests[6]. Those conformance suite tests are used to build automated machine-based processes to be sure the XBRL technical syntax is right in all details. But XBRL conformance suite tests do not, and cannot, check to see if the meaning conveyed by the XBRL-formatted information is correct.

Second, when one "audits" the financial information represented in the form of paper you are not auditing the paper, you are auditing the information represented on the paper. The meaning conveyed by the XBRL-formatted information and the meaning conveyed by paper-based information including electronic forms of paper or "e-paper" like HTML and PDF convey the exact same meaning.

Third, 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. 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 XBRL-based reports correctly even if those reports are not audited.

Fourth, 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.

1.4. "Strips of Paper" Analogy

Accountancy Europe issued a briefing paper, *Independent Assurance on European Electronic Format*[7]. In that paper, they make the following statement: (page 8, section 2.A, third paragraph)

---

[6] XBRL International, *XBRL 2.1*, https://specifications.xbrl.org/work-product-index-group-base-spec-base-spec.html

[7] Accountancy Europe, *Independent Assurance on European Electronic Format*, https://www.accountancyeurope.eu/wp-content/uploads/191217-ESEF-assurance-paper-FINAL_update_2.pdf

Reasoning that agrees with the EC's clarification can be described using an analogy. A set of financial statements presented on paper shows a particular presentation of the items in a certain order, structure and format together with disclosures which have to be "taken as a whole" – i.e. in a specific context. Auditors provide an opinion on this presentation, historically on paper. The items in the financial statements on that paper consist of both the title of each item and the monetary amount or disclosure. What XBRL does is akin to cutting out each financial statement item and disclosure on that paper together with its title into separate strips of paper. The tagging process is similar to attaching another strip of paper with the tag to each strip of paper with the financial statement item or disclosure. These combined (item with attached tag) strips of paper are individual strips in no ordered presentation (i.e., think of placing these in a bowl in random order – so can be sent without any particular order or presentation to a website/analyst etc.). XBRL allows users to efficiently search for the "strips of paper in the bowl" of interest to them electronically through the tag so that they can use them in their analyses or develop their own presentations. The key point is that the truth and fairness of the financial

In essence, what the authors appear to be pointing out is that historically, auditors provide an opinion of the financial statement taken as a whole. But, given that the XBRL technical syntax breaks the here-to-for whole report into individual pieces or as they say "strips of paper" and that XBRL also allows for access to reported information as if each reported fact is a "strip of paper in a bowl" and therefore can be individually accessed (i.e. using pieces of a report as contrast to using the whole financial report).

The paper also makes the statement:

"The key point is that the truth and fairness of the financial statements was achieved before the scissors were applied to cut the financial statements and also before the application of XBRL tags."

This paper looks at this analogy and that last statement in this briefing paper.

For additional thoughts on the audit of XBRL-based financial reports, I would invite you to have a look at *Auditing XBRL-based Financial Reports*[8].

1.4.1. Human Readable Rendering

In this section we cut a financial report into strips. We look at a simple fragment of a simple financial report and literally cut that report into strips.

The report I will use is the report which I created as part of the *Continuous Reporting*[9] example. I will use one fragment of that report, the balance sheet. Here you see a human readable rendering of the ASSETS section of the balance sheet of the *Continuous Reporting* example[10]:

---

[8] Charles Hoffman, CPA, *Auditing XBRL-based Financial Reports*, http://www.xbrlsite.com/mastering/Part03_Chapter06.G_AuditingDigitalReports.pdf

[9] *Continuous Reporting Example*, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/index.html

[10] *Pixel Perfect Rendering of Continuous Accounting Example*, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/instance-RENDERED.html

Balance Sheet

ABC Company, Inc.

(See accompanying notes to the financial statements.)

(in US Dollars)	As of December 31, 2020	As of December 31, 2019
ASSETS		
Current Assets:		
Cash and cash equivalents	$26900	$13000
Receivables	1000	1000
Inventories	1000	1000
Current assets	28900	15000
Noncurrent Assets:		
Property, plant, and equipment	13000	1000
Noncurrent assets	13000	1000
Assets	$41900	$16000

I would point out that there are clearly relationships between the reported facts. For example, one can easily understand the subcomponents of the subtotal "Current assets" in the human readable rendering above. When the report model is considered, the XBRL calculations clearly and absolutely show that relations exist between the reported facts.

Note that the human readable rendering above is also machine readable because the document is the Inline XBRL format. Extraction tools, such as an Excel spreadsheet application, can in fact extract individual facts from the document[11].

Notice that there is implied meaning associated with reported facts. For example, the value "$26900" is associated with the line item "Cash and Cash equivalents" because they are on the same line, the balance sheet date "December 31, 2020" because it is in that column, with the currency "US dollars" per the heading "(in US Dollars)", and with the economic entity "ABC Company, Inc" per the title of the balance sheet.

1.4.2.Cutting the Human Readable Rendering into Strips

Below, we literally take the above human readable rendering and cut it into strips such:

---

[11] Excel-based Information Extraction Tool, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/Extraction-TB-InlineXBRL.zip

Balance Sheet

ABC Company, Inc.
(See accompanying notes to the financial statements.)

(in US Dollars)	As of December 31, 2020	As of December 31, 2019
ASSETS		
Current Assets:		
Current Assets:		
Cash and cash equivalents	$26900	$13000
Receivables	1000	1000
Inventories	1000	1000
Current assets	28900	15000
Property, plant, and equipment	13000	1000
Noncurrent assets	13000	1000
Assets	$41900	$16000

Each line item is actually three "strips". For example, the line item "Cash and cash equivalents" is reported for the current balance sheet date of December 31, 2020 and the prior balance sheet data of December 31, 2019. And so, there are two strips for each line item description; one for the current balance sheet date and one for the prior balance sheet date.

Notice that there are relationships between the "strips". For example, there is a relationship between "Cash and cash equivalents", "Receivables", "Inventories" and "Current Assets". You can tell there are relationships because of the single underscores and double underscores (bold) in the rendering.

And so, the strips are not arbitrary. The strips need to be pieced together correctly.

1.4.3.Thinking "Cells" rather than "Strips"

Below, you see another version of the report "cut into strips" by automated processes[12]:

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	26,900.00	13,000.00
Receivables	1,000.00	1,000.00
Inventories	1,000.00	1,000.00
Current Assets	28,900.00	15,000.00
Noncurrent Assets [Roll Up]		
Property, Plant and Equipment	13,000.00	1,000.00
Noncurrent Assets	13,000.00	1,000.00
Assets	41,900.00	16,000.00

Using the XBRL Cloud Evidence Package, you can see information about each "strip" or cell. Further, you can click on any sell with a value and get information about that cell. For example, below you see information that describes the cell with the value of "28,900.00", the line item label "Current Assets" for the balance sheet date "2020-12-31":

Fact Characteristics and Properties

Characteristic, trait or fact	Value of characteristic, trait, or fact
Reporting Entity [Axis]	30810137d58f76b84afd (http://standards.iso.org/iso/17442)
Period [Axis]	2020-12-31
Concept	Current Assets
Fact value	28900
Units	USD
Decimals (rounding)	2
Parenthetical explanation (i.e. footnote)	(None)

Similar information exists for each report element that describes each reported number. For example, if you click on the line item "Current Assets" you will see:

---

[12] Balance Sheet Generated by XBRL Cloud, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/evidence-package/contents/index.html#Rendering-BalanceSheet-Implied.html

You can see that there is additional explicit information that describes the label "Current Assets"; it is a "DEBIT", it is "Monetary" in nature, and it is associated with the concept "tb:CurrentAssets". We also see that the label "Current Assets" is in English (i.e. "en") and that it is the "Standard label". All of this information is explicitly communicated as contrast to having to be implied by reading the human readable rendering itself.

Further, the associations between reported values are described in the report model and values are verified to be consistent with that machine-readable description[13]:

Label	Rendered	Reported	Calculated	Balance	Decimals	Message
Assets [Roll Up]						
Current Assets [Roll Up]						
Cash and Cash Equivalents	26,900 +	26,900	26,900	DR	2	
Receivables	1,000 +	1,000	1,000	DR	2	
Inventories	1,000 +	1,000	1,000	DR	2	
Current Assets	28,900 +	28,900	28,900	DR	2	OK
Noncurrent Assets [Roll Up]						
Property, Plant and Equipment	13,000 +	13,000	13,000	DR	2	
Noncurrent Assets	13,000 +	13,000	13,000	DR	2	OK
Assets	41,900	41,900	41,900	DR	2	OK

Finally, other rules represent information about mathematical relations between other values. The rules below are for the entire report and give you an idea of the extent of such mathematical relations even in rather small financial reports[14]:

---

[13] XBRL Cloud Evidence Package, Balance sheet calculation relations, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/evidence-package/contents/index.html#Rules-BalanceSheet-Implied.html

#	Label	Result	Rule
1	$PropertyPlantAndEquipment_BalanceStart + $CapitalAdditionsPropertyPlantAndEquipment - $DepreciationAndAmortization - $PropertyPlantAndEquipmentWrittenOff = $PropertyPlantAndEquipment_BalanceEnd (RollForward_RF6)	Pass	$PropertyPlantAndEquipment_BalanceStart + $CapitalAdditionsPropertyPlantAndEquipment - $DepreciationAndAmortization - $PropertyPlantAndEquipmentWrittenOff = $PropertyPlantAndEquipment_BalanceEnd
2	$LongtermDebt_BalanceStart + $AdditionalLongtermBorrowings - $RepaymentLongtermBorrowings = $LongtermDebt_BalanceEnd (RollForward_RF8)	Pass	$LongtermDebt_BalanceStart + $AdditionalLongtermBorrowings - $RepaymentLongtermBorrowings = $LongtermDebt_BalanceEnd
3	$NetCashFlow = ($NetCashFlowOperatingActivities + $NetCashFlowFinancingActivities + $NetCashFlowInvestingActivities) (Arithmetic_CF01)	Pass	$NetCashFlow = ($NetCashFlowOperatingActivities + $NetCashFlowFinancingActivities + $NetCashFlowInvestingActivities)
4	$Inventories_BalanceStart + $PurchasesOfInventoryForSale - $CostsOfSales - $InventoryWrittenOff = $Inventories_BalanceEnd (RollForward_RF5)	Pass	$Inventories_BalanceStart + $PurchasesOfInventoryForSale - $CostsOfSales - $InventoryWrittenOff = $Inventories_BalanceEnd
5	$Assets = ($Liabilities + $Equity) (Arithmetic_BS01)	Pass	$Assets = ($Liabilities + $Equity)
6	$Assets = ($Liabilities + $Equity) (Arithmetic_BS01)	Pass	$Assets = ($Liabilities + $Equity)
7	$Receivables_BalanceStart + $Sales - $CollectionReceivables - $AdditionsToAllowanceForBadDebts - $BadDebtsWrittenOff = $Receivables_BalanceEnd (RollForward_RF4)	Pass	$Receivables_BalanceStart + $Sales - $CollectionReceivables - $AdditionsToAllowanceForBadDebts - $BadDebtsWrittenOff = $Receivables_BalanceEnd
8	$AccountsPayable_BalanceStart + $PurchasesOfInventoryForSale - $PaymentOfAccountsPayable = $AccountsPayable_BalanceEnd (RollForward_RF7)	Pass	$AccountsPayable_BalanceStart + $PurchasesOfInventoryForSale - $PaymentOfAccountsPayable = $AccountsPayable_BalanceEnd
9	$RetainedEarnings_BalanceStart + $NetIncomeLoss = $RetainedEarnings_BalanceEnd (RollForward_RF9)	Pass	$RetainedEarnings_BalanceStart + $NetIncomeLoss = $RetainedEarnings_BalanceEnd
10	$CashAndCashEquivalents_BalanceStart + $NetCashFlow = $CashAndCashEquivalents_BalanceEnd (RollForward_RF1)	Pass	$CashAndCashEquivalents_BalanceStart + $NetCashFlow = $CashAndCashEquivalents_BalanceEnd
11	$Equity_BalanceStart + $NetIncomeLoss = $Equity_BalanceEnd (RollForward_RF2)	Pass	$Equity_BalanceStart + $NetIncomeLoss = $Equity_BalanceEnd
12	$CashAndCashEquivalents_BalanceStart + $CollectionReceivables - $PaymentOfAccountsPayable + $AdditionalLongtermBorrowings - $RepaymentLongtermBorrowings - $CapitalAdditionsPropertyPlantAndEquipment = $CashAndCashEquivalents_BalanceEnd (RollForward_RF3)	Pass	$CashAndCashEquivalents_BalanceStart + $CollectionReceivables - $PaymentOfAccountsPayable + $AdditionalLongtermBorrowings - $RepaymentLongtermBorrowings - $CapitalAdditionsPropertyPlantAndEquipment = $CashAndCashEquivalents_BalanceEnd
13	$Assets = ($CurrentAssets + $NoncurrentAssets) (Arithmetic_BS02)	Pass	$Assets = ($CurrentAssets + $NoncurrentAssets)
14	$Assets = ($CurrentAssets + $NoncurrentAssets) (Arithmetic_BS02)	Pass	$Assets = ($CurrentAssets + $NoncurrentAssets)
15	$Liabilities = ($CurrentLiabilities + $NoncurrentLiabilities) (Arithmetic_BS03)	Pass	$Liabilities = ($CurrentLiabilities + $NoncurrentLiabilities)
16	$Liabilities = ($CurrentLiabilities + $NoncurrentLiabilities) (Arithmetic_BS03)	Pass	$Liabilities = ($CurrentLiabilities + $NoncurrentLiabilities)

Notice that rules #5 and #6 specify that the balance sheet needs to balance, "Assets = Liabilities + Equity" and the green cell in the "Result" column which says "Pass" indicates that the values for the current and prior balance sheets are consistent with this rule (although the values for each computation are not shown, this is a flaw in the XBRL Cloud software application).

You see that rules #13, #14, #15, and #16 likewise test balance sheet values.

1.4.4. Unformatted Auto-generated Rendering

Another rendering of the report information shows the "strips of paper" that make up the report with great clarity. The rendering you see below as auto-generated, the representation format is Inline XBRL, but there is no organized presentation of the information, it simply serializes the raw facts that are reported. This screen shot shows a fragment of the report but if you go to the actual report you can see 100% of the reported facts[15]:

tb:DepreciationAndAmortization2	2020-01-01 | 2020-12-31	3,000
tb:Inventories	2020-12-31	1,000
tb:CashAndCashEquivalents	2019-12-31	13,000
tb:Inventories	2019-12-31	1,000
tb:LongtermDebt	2019-12-31	1,000
tb:PropertyPlantAndEquipment	2019-12-31	1,000
tb:Receivables	2019-12-31	1,000
tb:RetainedEarnings	2019-12-31	14,000
tb:BadDebtsWrittenOff	2020-01-01 | 2020-12-31	0

---

[14] XBRL Cloud Evidence Package, Business Rules Summary, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/evidence-package/contents/index.html#BusinessRulesSummary.html
[15] Auto-generated rendering, http://xbrlsite.azurewebsites.net/2020/master/continuous-accounting/instance-generated.html

Note that this representation also includes facts from other report fragments.

While the facts or values are provided in a flat list with no formatting to speak of; that does not mean that information provided can be inconsistent with or contradict other reported information. The rules from the previous section still apply regardless of how the information is presented.

1.4.5. About Meaning Conveyed, not Medium Used

The Accountancy Europe paper makes the following statement: (pages 8 and 9, section 2.A, third paragraph)

"The key point is that the truth and fairness of the financial statements was achieved before the scissors were applied to cut the financial statements and also before the application of XBRL tags."

In my view, that statement is not accurate. A financial report represents information about an economic entity. The medium used to convey that meaning is different than the actual information conveyed.

Auditors audit information, not the medium. Or, perhaps it is more accurate to say that auditors concern themselves with how information is conveyed using a medium. Auditors are familiar with the medium "paper" but less with the digital medium "XBRL".

Should auditors concern themselves with the proper use of the XBRL technical syntax? Well, sure they should but not how you might think. XBRL International published an XBRL *Conformance Suite*[16]. That Conformance Suite makes sure that software is working with XBRL appropriately. All that an auditor needs to do is run any XBRL-based financial report through software that complies with the XBRL Conformance Suite published by XBRL International and they will know whether the XBRL-based report is properly formatted XBRL technical syntax.

Further, ESMA likewise publishes a conformance suite.[17] Software implements that conformance suite and like the XBRL International Conformance Suite will tell you if the XBRL-based report is consistent with those machine-readable rules.

So, what does the auditor have to do to check the XBRL? Well; nothing but run those conformance suite tests to be sure the technical syntax rules are being adhered to and that ESEF rules are adhered to.

Does that mean the XBRL-based report is correct? No. The auditor does need to check the meaning conveyed by the information represented using the XBRL formatted information to be sure the meaning conveyed is correct.

For example, consider this "strip of paper":

---

[16] XBRL International, XBRL 2.1, https://specifications.xbrl.org/work-product-index-group-base-spec-base-spec.html
[17] ESMA PUBLISHES ESEF CONFORMANCE SUITE, https://www.esma.europa.eu/press-news/esma-news/esma-publishes-esef-conformance-suite

The auditor needs to satisfy themselves that the concept used to represent that piece of information is the appropriate concept. The auditor should satisfy themselves that the reported fact is not inconsistent logically from other reported facts or that one fact does not contradict another fact. The auditor should make sure every mathematical relation is consistent with expectation.

The "terms" and "associations" between terms and "structures" used to express associations and "rules" used to specify what is permissible and what is not permissible and "facts" reported by the economic entity and explained by the report model using those logical statements that physically exist within such an XBRL-based report is the meaning conveyed by the report. That meaning should be (a) true and fair and (b) consistent with the logic of accounting as the auditor understands accounting.

A financial report is a logical system[18]. That logical system needs to function properly.

What is particularly interesting is that it is trivial to measure how good the auditors are doing in terms of the logic of the report. It is trivial for software to look at thousands or even tens of thousands of reports and check those reports against the known logic of financial accounting and reporting[19].

1.4.6. Automation and Augmented Intelligence

The machine-readable XBRL technical syntax allows certain tasks and processes to be automated. This automation will most certainly make creating such reports cheaper, improve report quality, and make creating such reports take less time. Further, if the proper software is used that understands the structured information and if all the right rules are provided, then auditors can be much "smarter". Every auditor can be as smart as the smartest auditor that helped to create the machine-readable rules.

The Accountancy Europe briefing paper is right to say that the audit is done before "the XBRL tags are applied". Most organizations "bolt on" the process of creating XBRL-based reports to the end of existing processes.

But what if that information was added to accounting systems and then flowed through the entire accounting, reporting, auditing, and even analysis processes. The fact is, that is the only way automation can be achieved.

The way I see it is that continuous accounting and continuous auditing are theoretical objectives, goals that people are striving to reach. Can "continuous" really be reached? Time will provide the answer. Focusing on whether everything can or cannot be automated is missing the point. Can certain specific tasks or processes be automated? How smart is it to keep all current processes as they are and then digitize reports at the end of the process? Perhaps it might work to introduce the machine-readable meaning earlier in the process, perhaps even at transaction entry.

---

[18] Charles Hoffman, CPA, *Logical Theory Describing Financial Report*,
http://xbrl.squarespace.com/logical-theory-financial-rep/
[19] Quarterly XBRL-based Public Company Financial Report Quality Measurement (March 2019),
http://xbrl.squarespace.com/journal/2019/3/29/quarterly-xbrl-based-public-company-financial-report-quality.html

No one can predict every aspect of the future with 100% clarity. Optimists tend to overestimate capabilities; pessimists tend to underestimate capabilities. The right answer will be somewhere between what the optimists and the pessimists are predicting.

1.5. Describing a Logical System

A **logical system**[20] (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 common models, structures, and statements for capturing meaning or representing a shared understanding of and knowledge in some universe of discourse.

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

- **Logical theory**: A logical theory is a set of *models* that are consistent with that logical theory.

- **Model**: A model is a set of *structures*. A model is an interpretation of a theory.

- **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. There are four broad categories of statements:

  o **Terms**: Terms are statements that define ideas used by the logical theory such as "assets", "liabilities", and "equity".

  o **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".

  o **Assertions**: Assertions 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"

  o **Facts**: Facts are statements about the numbers and words that are provided by an economic entity within their financial report. For example, "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.

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

---

[20] Charles Hoffman, CPA, *Understanding and Expressing Logical Systems*, http://xbrl.squarespace.com/journal/2019/9/25/understanding-and-expressing-logical-systems.html

1.6. *Proving the Logical System is Properly Functioning*

A financial report is a set of statements. That set of statements on paper or "e-paper" (HTML, PDF) is a man-made logical system. But that logical system is only understandable by humans who read the set of statements.

An XBRL-based report is a machine-readable logical system. Said another way, financial reports are not arbitrary, haphazard, illogical, or random.

Logic programming[21] is a way of processing those statements reliably using automated machine-based processes.

Predicate logic[22] is based on and extends propositional logic[23]. Propositional logic which is also known as statement logic is based on the truth value of some set of one to many propositions or statements. A statement is defined as "a proposition, claim, assertion, belief, idea, or fact about or related to the universe of discourse." A financial report is a logical system that contains a set[24] of statements[25]. That set of statements is essentially a "chain" or chain of reasoning[26].

And so, a **logical system is the set of statements** that can be chained together using logical connectors. These statements represented as sets of models, structures, terms, assertions, associations, and facts are all forms of statements or propositions[27]. The set of statements can be proven to be consistent, valid, sound, complete, and fully expressed; then the financial report logical system can be proven to be properly functioning. The financial report is then in equilibrium. If one statement within the system is changed in some way, it is typically the case that some other statement likewise must be changed in order to keep the financial report logical system of statements in equilibrium.

A well-defined logical system, when **fully expressed** and in equilibrium, should be properly functioning and demonstrably **consistent**, **valid**, **sound**, and **complete**. The following are definitions of these terms:

- **Consistent**: No statement of the logical system contradicts another statement within that same logical system.

- **Valid**: No false inference (logical deduction of a statement) from a true premise is possible.

- **Complete**: If a statement is true, then that statement can be proven; i.e. all statement exists in the system.

- **Sound**:   If any statement is a theorem (an IF…THEN assertion) of the logical system; then the theorem is true.

- **Fully expressed**: If an important term exists in the real world; then the term can be represented within the logical system.

---

[21] Wikipedia, *Logic Programming*, https://en.wikipedia.org/wiki/Logic_programming
[22] Wikipedia, *First-order Logic*, https://en.wikipedia.org/wiki/First-order_logic
[23] Wikipedia, *Propositional Calculus*, https://en.wikipedia.org/wiki/Propositional_calculus
[24] Wikipedia*, Set Theory*, https://en.wikipedia.org/wiki/Set_theory
[25] Charles Hoffman, CPA, *Understanding and Expressing Logical Systems*,
http://xbrl.squarespace.com/journal/2019/9/25/understanding-and-expressing-logical-systems.html
[26] Charles Hoffman, CPA, *Constructing a Chain of Reasoning*,
http://xbrl.squarespace.com/journal/2019/9/26/constructing-a-chain-of-reasoning.html
[27] Charles Hoffman, CPA, *Understanding and Expressing Logical Systems*,
http://xbrl.squarespace.com/journal/2019/9/25/understanding-and-expressing-logical-systems.html

It is desirable to have a well-defined logical system that is fully expressed that is proven to be properly functioning and demonstrably consistent, valid, sound, and complete. This equilibrium is similar to the equilibrium of double-entry accounting.

1.7. Understanding the System is Properly Functioning

Depicting all that I am trying to articulate graphically, perhaps it might look something like this:

Properly Functioning System
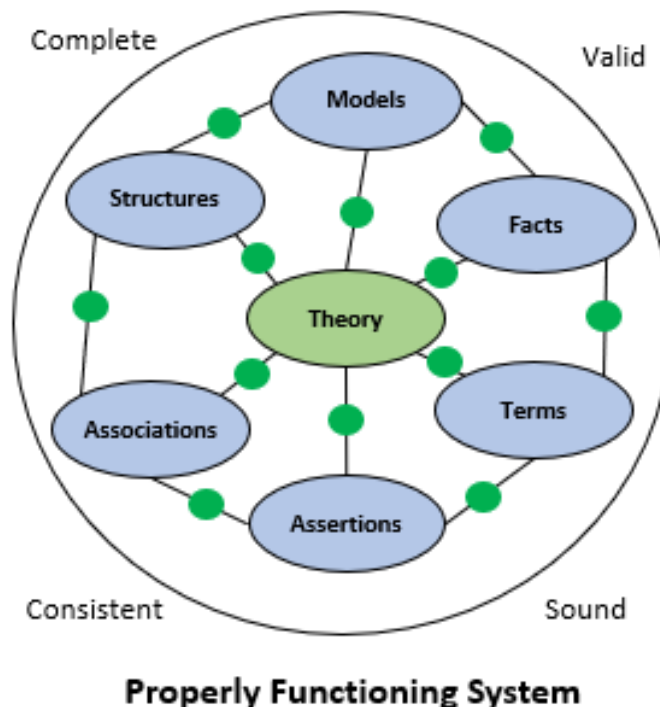
Now, this graphic communicates an idea, not a logical thing that can be measured. I would like to come up with a better graphic.

Think of this as a *complete* set of statements that have to be *consistent* and everything has to be *valid* and if you achieve this then the system is *sound*. If all those four constraints are met and the system is *fully expressed*, then the **system is functioning properly**. Two different people can look at the same set of statements and reach the same conclusion.

What is more, you can prove that the system is functioning properly, the full set of statements is like a "parity check" or a "check sum".

While I cannot provide a graphic that visually proves that a logical system can be verified to be properly functioning, software applications exist which can and more importantly the notion of properly functioning is not a new or novel idea. Implementations of logic systems such as Prolog[28], Datalog[29], Clips[30], and Answer

---

[28] Wikipedia, *Prolog*, https://en.wikipedia.org/wiki/Prolog
[29] Wikipedia, *Datalog*, https://en.wikipedia.org/wiki/Datalog
[30] Wikipedia, *Clips*, https://en.wikipedia.org/wiki/CLIPS

Set Programming[31] all perform this task and provide the general idea that all this can be proven. XBRL processors and XBRL formula processors can effectively be used to detect specific logical errors if trying to verify one single specific report but tend to not be as effective and efficient as general logic programming applications[32].

To be crystal clear, when I say logical system, I mean the most safe and reliable logical system that can be achieved and also with the maximum expressiveness[33] that is achievable.

Specifically, I mean a **finite deductive first-order logic system**[34]. The point is to create a logical system that has high expressive capabilities but is also a provably safe and reliable system that is free from catastrophic failures and logical paradoxes. This is done by consciously and carefully selecting the specific pieces that make up that system:

- Axiomatic (Zermelo–Fraenkel) set theory[35] is used as contrast to naïve set theory[36].

- All associations are expressed as directed acyclic graphs[37] that do not cause cycle problems.

- The closed world assumption[38] is made so that decidability is not a problem and to be consistent with relational databases.

- Negation as failure[39] is assumed to be clear and avoid known problems with alternative approaches.

- The unique name assumption[40] is made to be clear and to avoid known problems.

- Horn logic[41] to avoid logical paradoxes.

Terms that I have heard that describe this sort of rock-solid, sound system are stable model semantics[42] and well-founded semantics[43]. Basically, technical people have been trying to get all this stuff to work for the past 50 years and that knowledge needs to be understood and leveraged.

I am not saying that I have 100% of the details precisely correct, but I do believe that the intent of what I am trying to achieve is clear and can be understood. Further, all this is provable by using software applications that exist today.

[31] Wikipedia, *Answer Set Programming*, https://en.wikipedia.org/wiki/Answer_set_programming
[32] Charles Hoffman, CPA, *Specific Deficiencies in Capabilities of Existing XBRL Formula Processors*, http://xbrl.squarespace.com/journal/2016/9/26/specific-deficiencies-in-capabilities-of-existing-xbrl-formu.html
[33] Charles Hoffman, CPA, *Revisiting the Knowledge Representation Spectrum*, http://xbrl.squarespace.com/journal/2019/10/9/revisiting-the-knowledge-representation-spectrum.html
[34] Wikipedia, *First-order Logic, Deductive System*, https://en.wikipedia.org/wiki/First-order_logic#Deductive_systems
[35] Wikipedia, *Set Theory, Axiomatic Set Theory*, https://en.wikipedia.org/wiki/Set_theory#Axiomatic_set_theory
[36] Wikipedia, *Naïve Set Theory*, https://en.wikipedia.org/wiki/Naive_set_theory
[37] Wikipedia, *Directed Acyclic Graph*, https://en.wikipedia.org/wiki/Directed_acyclic_graph
[38] Wikipedia, *Closed World Assumption*, https://en.wikipedia.org/wiki/Closed-world_assumption
[39] Wikipedia, *Negation as Failure*, https://en.wikipedia.org/wiki/Negation_as_failure
[40] Wikipedia, *Unique Name Assumption*, https://en.wikipedia.org/wiki/Unique_name_assumption
[41] Wikipedia, *Horn Logic*, https://en.wikipedia.org/wiki/Horn_clause
[42] Wikipedia, *Stable Model Semantics*, https://en.wikipedia.org/wiki/Stable_model_semantics
[43] Wikipedia, *Well-founded Semantics*, https://en.wikipedia.org/wiki/Well-founded_semantics

1.8. Logical Statements, Not XBRL Technical Syntax

Within an XBRL-based report, every statement is a logical statement (i.e. nothing is technical); you never interact with the XBRL technical syntax. This is done by using a logical theory that explains how a financial report works[44] and a framework[45] for implementing that logical theory within software applications. When you interact with software created using this framework, XBRL literally disappears into the background and professional accountants interact with the software using terms they understand[46].

Further, while some prefer the XBRL technical syntax, others might prefer the Semantic Web Stack[47] of technologies. OMG is even taking steps with their *Standard Business Report Model (SBRM)*[48] to create a logical conceptualization of a business report that is technical syntax agnostic. Another technical syntax alternative is JSON. Fads, trends, and arbitrary personal preferences, point to the need to support multiple technical syntax alternatives.   All these alternative technical syntax alternatives have one thing in common: logic.

1.9. Logic of Financial Statements

The basic high-level model of a financial report follows double-entry accounting and is described by the accounting equation which is a logical statement[49]:

Assets = Liabilities + Equity

Standards setters create financial reporting schemes which provide further details which expand on the accounting equation. By definition a standards setter cannot violate the accounting equation. The financial reporting scheme essentially defines a core set of *classes* of elements[50] used by that financial reporting scheme which reconciles to the accounting equation. The elements of financial statements are the building blocks, or **classes** of defined elements, with which financial statements are constructed by an economic entity reporting per some financial reporting scheme.

The **items** in the financial statements of a specific economic entity represent in words and numbers certain entity resources, claims against those resources, and the effects of transactions and events, circumstances, and other phenomenon that result in changes in those resources and claims. Those words and numbers are statements the economic entity makes to describe their financial position and financial performance.

These classes of building blocks are **intentionally interrelated mathematically** within the four core statements that make up a financial report; this is called 'articulation'.

---

[44] Charles Hoffman, CPA and Rene van Egmond, *Financial Report Semantics and Dynamics Theory*, http://xbrlsite.azurewebsites.net/2016/Library/Theory-2017-06-26.pdf
[45] Charles Hoffman, CPA, *Open Source Framework for Implementing XBRL-based Digital Financial Reporting*, http://xbrlsite.azurewebsites.net/2019/Framework/FrameworkEntitiesSummary.html
[46] Charles Hoffman, CPA, *Narrative Explaining Logical Conceptualization of a Financial Report*, http://xbrlsite.azurewebsites.net/2019/Framework/NarrativeConceptualization.pdf
[47] Wikipedia, *Semantic Web Stack*, https://en.wikipedia.org/wiki/Semantic_Web_Stack
[48] OMG, *Standard Business Report Model* (SBRM), https://omgwiki.org/SBRM/doku.php
[49] Charles Hoffman, CPA, *Accounting Equation*, http://xbrlsite.azurewebsites.net/2019/core/core-ae/Documentation.pdf
[50] Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*, http://xbrlsite.azurewebsites.net/2019/Core/ElementsOfFinancialStatements.pdf

Intermediate components, i.e. subtotals, can be used to represent the items of an economic entity within the items that comprise a financial report of the economic entity. However, these intermediate components and the items must fit into the core framework of the classes of elements that are the building blocks of any financial report created using a specific reporting scheme.

The *balance sheet* provides a roll up of assets, a roll up of liabilities and equity, and is bound by the rule "Assets = Liabilities + Equity". The *income statement* is used to compute the roll up total "Net Income" and there are rules for how the intermediate components (i.e. subtotals) of Net Income roll up. Net income then flows to the *statement of changes in equity* which is a roll forward which reconciles beginning and ending equity on the current and prior balance sheets. The *cash flow statement* is a roll up of Net Cash Flow, rules that specify how the intermediate components (i.e. subtotals) of net cash flow roll up, and a roll forward of the asset Cash and Cash Equivalents which reconciles the beginning and ending balance of that asset on the balance sheet[51].

And so, the primary financial statements are explained by:

1. The accounting equation.

2. Some set of elements of the financial statements[52] such as those for IFRS[53]: Assets, Liabilities, Equity, Contributions from Holders of Equity Claims, Distributions to Holders of Equity Claims, Income and Expenses, Income, Expenses.

3. The fundamental relations between the elements where T0 is the beginning balance sheet date, T1 is the ending balance sheet date, and P1 is the current period that reconciles the beginning and ending balance sheet: $0 = \text{Equity}^{T0} + \text{Income}^{P1} - \text{Expenses}^{P1} + \text{ContributionsFromHoldersOfEquityClaims}^{P1} - \text{DistributionsToHoldersOfEquityClaims}^{P1} + \text{Assets}^{T1} - \text{Liabilities}^{T1}$

While the model shown above which is based on "Assets = Liabilities and Equity"; some economic entities use different sorts of models. For example, some economic entities report using a liquidation basis style balance sheet where "Assets - Liabilities = Net Assets". "Net Assets" and "Equity" are two different labels for what is the same concept.

---

[51] Four statement model, http://xbrlsite.azurewebsites.net/2019/Core/core-ifrs/FourStatements_IFRS.jpg

[52] Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*, http://xbrlsite.azurewebsites.net/2019/Core/ElementsOfFinancialStatements.pdf

[53] Core Elements of Financial Statements (IFRS), http://xbrlsite.azurewebsites.net/2019/Core/core-ifrs/

Using the rules of mathematics, the equation "Assets = Liabilities + Equity" can be converted to "Assets - Liabilities = Equity".

So, while a financial report is not a static form it is not random either. Financial reports follow patterns and these patterns can be explained using specific models to account for and manage the variability inherent in a financial report. Each set of items in the financial report of an economic entity must follow the accounting equation and the elements of a financial statement defined by some financial reporting scheme.

1.10. Similarity to Double-entry Accounting

I see this as having similarities to the double-entry accounting system. The double-entry accounting approach offers a "parity check" by basically requiring two entries for each transaction. Essentially, double-entry accounting is concurrently using two single-entry ledgers in order to detect errors and tying that ledger with the accounting equation, "Assets = Liabilities and Equity".

This approach is similar in that all of the statements describing the financial report and the facts that are provided within that report are tested using automated machine-based processes to be sure the mechanical details are all appropriate.

This is not to say that automated processes can verify that 100% of the report details are appropriate, that is not currently possible and might never be possible. Verifying a report will always be a collaboration between a human and a machine that is providing assistance where it can. The actual third-party verification provided by an auditor still needs to be performed to verify the truth of each statement that exists. The logical system can only tell you if the statements that do exist are consistent with one another and other such details.

An XBRL-based financial report which is comprised of an XBRL taxonomy plus an XBRL instance can borrow this idea from double-entry accounting. While the notion of a "double-entry XBRL taxonomy" is not a perfect one (and might even make knowledge engineers cringe), it does make an important point between allowed variability and the rules necessary to control and manage that variability. When information is added to an XBRL taxonomy, other information must also be added in order to control, manage, and ultimately channel business professionals to success.

And so, if a new term is added; then one or more new associations or assertions will likely also need to be added.

More importantly, if business professionals can reliably create such machine-readable logical systems that will very likely have a very positive and significant impact on the functioning of an enterprise just as double-entry accounting had a significant impact on the enterprise. With the ever-increasing complexity and volume of information, being able to leverage machines effectively to help humans perform work is important.

1.11. Reconciling Logic Terms to Common Audit Terms

The five terms I used to describe a logical system that is functioning properly are not my terms. These terms are taken from logic and the definition of a logical system[54]: complete, consistent, valid, sound, fully expressed. Further, I have changed the

---

[54] Wikipedia, *Logic*, *Logical System*, https://en.wikipedia.org/wiki/Logic#Logical_systems

definitions slightly in order to make the definitions consistent with the terms I used to explain the components of logical systems.

Below, I have provided similar terms that are more common to professional accountants and auditors when thinking about financial reports:

- **Completeness**: All relevant statements have been included within the financial report representation.

- **Existence**: No statement exists which should not be included in the financial report has been included.

- **Accuracy**: The statements are included in the financial report are accurate, correct, and precise.

- **Fidelity**: Considered as a whole; the statements provided in the financial report are a loyal representation of the actual financial position and financial performance of the reporting economic entity.

- **Integrity**: The statements that describe each part of a financial report provide a true and fair representation of such part and no parts are inconsistent with or contradict any other financial report part.

- **Consistency**: The statements are consistent with prior periods and with the reporting entity's peers as is deemed appropriate.

- **True and fair representation**: The statements of the financial report are a true and fair representation of the information of the reporting economic entity.

Optimally, the terms used to describe logical systems and the terms used by professional accountants and auditors should be reconcilable from one to the other.

1.12. Very Basic Example

The following provides a very basic example of the statements that might exist within a financial report. This very basic example provides statements for the accounting equation[55] and facts for an economic entity. Here is a robust sample that helps you understand, but not 100%, of all statements:

- Terms:
  - o Assets is-a term.
  - o Liabilities is-a term.
  - o Equity is-a term.
  - o Balance sheet is-a term.

- Associations:
  - o Assets has-property balance of debit.
  - o Liabilities has-property balance of credit.
  - o Equity has-property balance of credit.
  - o Assets has-property period of instant.

---

[55] *Accounting Equation*, http://xbrlsite.azurewebsites.net/2019/core/core-ae/Documentation.pdf

- o Liabilities has-property period of instant.

- o Equity has-property period of instant.

- Structure

  - o Balance sheet has-part Assets.

  - o Balance sheet has-part Liabilities.

  - o Balance sheet has-part Equity.

- Assertions:

  - o Assets = Liabilities + Equity

- Facts:

  - o ABC Company is an economic entity.

  - o Assets for December 31, 2019 for ABC Company is $5,000 US Dollars.

  - o Liabilities for December 31, 2019 for ABC Company is $1,000 US Dollars.

  - o Equity for December 31, 2019 for ABC Company is $4,000 US Dollars.

The statements are not machine readable, but they could be[56]. So above you see all of the statements that exist within this very basic example of a financial report. Per all the statements, the system appears to be properly functioning. But, suppose that the value for the fact "Assets" was changed to say $5,500. If that were the case, because there is a assertion that specifies "Assets = Liabilities + Equity" and because of the values of Liabilities and Equity, the logical system would NOT be functioning properly. If that assertion did not exist, the system would not be considered "complete".

Here is this same example represented in XBRL including the facts[57], terms[58], associations[59], and assertions[60].   There is not a 100% correlation to keep the example easy to follow. The XBRL can be processed using global standard off-the-shelf software. In fact, two completely different XBRL processing tools were used created by different software vendors and each software application provides the same results.

Software #1:

Terms and property associations:

Prefix	Label /	Name	Data Type	Abstr...	Substitutio...	Balance	Period Type
core	Assets	Assets	Monetary	False	xbrli:item	Debit	Instant
core	Balance Sheet [Abstract]	BalanceSheetAbstract	String	True	xbrli:item		Instant
core	Equity	Equity	Monetary	False	xbrli:item	Credit	Instant
core	Liabilities	Liabilities	Monetary	False	xbrli:item	Credit	Instant

Structure:

---

[56] Wikipedia, *Attempto Controlled English*, https://en.wikipedia.org/wiki/Attempto_Controlled_English

[57] XBRL instance, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/instance.xml

[58] XBRL taxonomy schema, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/core.xsd

[59] XBRL presentation relations, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/core-presentation.xml

[60] XBRL formula, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/core-formula.xml
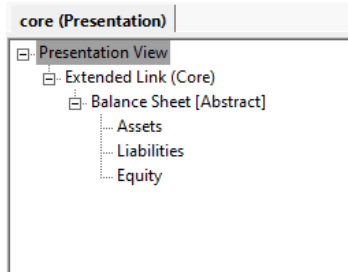
XBRL syntax validation report:

Assertions validation:

Summary

Formulas Compiled	Formula Fired	Assertions Compiled	Assertions Fired	Assertions Satisfied	Assertions Not Satisfied
0	0	1	1	1	0

Assertion Report

Value Assertions

id	satisfied	message
ASSERTION_CORE_Equality_AccountingEquation (evaluation 1)	satisfied	$Assets=5000 = $Liabilities=1000 + $Equity=4000

Software #2:

Human readable representation[61]:

Balance Sheet [Abstract]	Period [Axis]
	2020-12-31
Balance Sheet [Abstract]	
Assets	5,000
Liabilities	1,000
Equity	4,000

---

[61] Human readable rendering, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/evidence-package/contents/index.html#Rendering-Core-Implied.html

Terms and associations[62]:

#	Label	Report Element Class	Period Type	Balance	Name
1	**Core [Table]**				(Implied)
2	*Balance Sheet [Abstract]*	[Abstract]			core:BalanceSheetAbstract
3	Assets	[Concept] Monetary	As Of	Debit	core:Assets
4	Liabilities	[Concept] Monetary	As Of	Credit	core:Liabilities
5	Equity	[Concept] Monetary	As Of	Credit	core:Equity

Facts[63]:

#	Reporting Entity [Axis]	Period [Axis]	Concept	Fact Value	Unit	Rounding	Parenthetical Explanations
1	GH259400TOMPUOLS65II (http://standards.iso.org/iso/17442)	2020-12-31	Assets	5000	USD	INF	
2	GH259400TOMPUOLS65II (http://standards.iso.org/iso/17442)	2020-12-31	Liabilities	1000	USD	INF	
3	GH259400TOMPUOLS65II (http://standards.iso.org/iso/17442)	2020-12-31	Equity	4000	USD	INF	

XBRL technical syntax validation[64]:

Verification Summary	A	M
XBRL Technical Syntax Rules	OK	OK
Model Structure Rules	OK	OK
Business Rules	OK	OK
Roll Up Rules	NS	NS
Other Manual Review Tasks	NS	NS
Other Rules and Best Practice Tasks	OK	OK

Assertions validation[65]:

#	Label	Result	
1	Accounting Equation (Assets = Liabilities and Equity) (ASSERTION_CORE_Equality_AccountingEquation)	Pass	$Assets = $Liabilities + $Equity

While XBRL processors cannot currently perform all the tasks that logic programming implementations can perform, they do an appropriate job when there is only one model.

The logical system can be called properly functioning because all of the statements are consistent with one another, there are no contradictions, it can be established that the logical system created precisely reflects the reality of the logical system and all the statements seem to be included within the logical system.

A software application can take all of the statements made within the machine-readable version of this logical system and perform work. Below you see a human-readable rendering of a balance sheet:

---

[62] Human readable model structure, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/evidence-package/contents/index.html#NetworkStructure-Core-Implied.html

[63] Human readable facts, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/evidence-package/contents/index.html#NetworkFacts-Core-Implied.html

[64] Human readable report properties including validation, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/evidence-package/contents/index.html#ReportProperties.html

[65] Business rules summary, http://xbrlsite.azurewebsites.net/2019/Core/core-audit/evidence-package/contents/index.html#BusinessRulesSummary.html
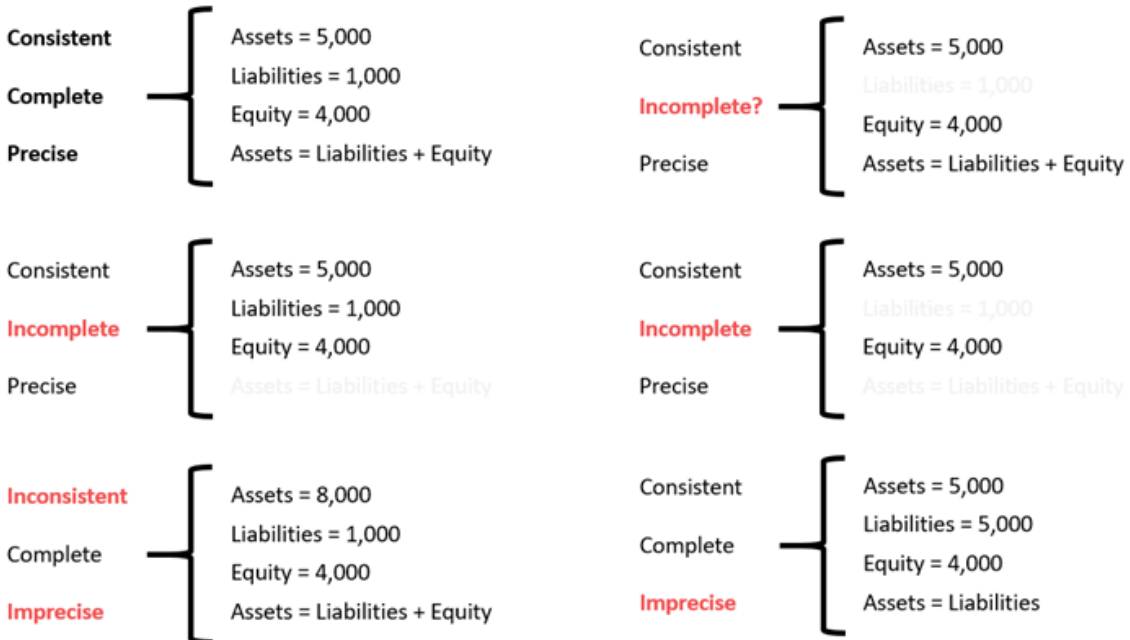
Balance Sheet [Abstract]	Period [Axis]
	2020-12-31
Balance Sheet [Abstract]	
Assets	5,000
Liabilities	1,000
Equity	4,000

Result	Rule
Pass	$Assets = $Liabilities + $Equity

The logical system of the accounting equation in this case is precise and complete because all the statements are consistent with one another:

Consistent

Complete — Assets = 5,000
Liabilities = 1,000
Equity = 4,000
Precise Assets = Liabilities + Equity
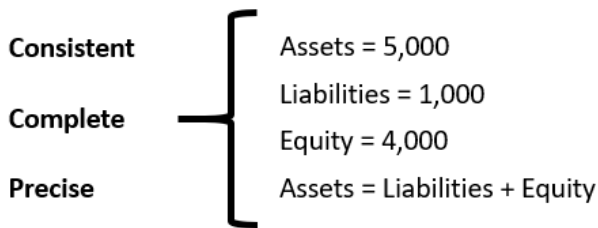
Below you can see examples of possible states of the accounting equation logical system. If a statement is left out, if one statement contradicts another statement, if statements are imprecise, etc.; the logical system is impacted.

Consistent

Complete — Assets = 5,000
Liabilities = 1,000
Equity = 4,000
Precise Assets = Liabilities + Equity

Consistent

Incomplete? — Assets = 5,000
Liabilities = 1,000
Equity = 4,000
Precise Assets = Liabilities + Equity

Consistent

Incomplete — Assets = 5,000
Liabilities = 1,000
Equity = 4,000
Precise Assets = Liabilities + Equity

Consistent

Incomplete — Assets = 5,000
Liabilities = 1,000
Equity = 4,000
Precise Assets = Liabilities + Equity

Inconsistent

Complete — Assets = 8,000
Liabilities = 1,000
Equity = 4,000
Imprecise Assets = Liabilities + Equity

Consistent

Complete — Assets = 5,000
Liabilities = 5,000
Equity = 4,000
Imprecise Assets = Liabilities

Again, keep in mind that we are trying to keep this example very basic. However, these same principles apply to, say, the Microsoft 10-K which has 194 different structures, many thousand associations, hundreds of assertions, and many thousand facts. This also works with US GAAP and IFRS.

In fact, every XBRL-based financial report submitted to the SEC or otherwise works exactly the same way as the accounting equation example. The other reports simply have different and more terms, associations, assertions, facts, and structures.

1.13. Expanded Example

Typical XBRL taxonomy creation practices focus on concept creation prematurely, before they have considered the broader motivating goals and objectives. This approach is like starting to build a house by laying bricks, rather than drawing plans and establishing foundations. It is critical to a framework and theory that will assure that your goals and objectives will be realized. A **framework** is a set of principles, assumptions, ideas, concepts, values, rules, laws, agreements, and practices that establishes the way something operates. A **theory** is a tool for understanding, explaining, and making predictions about a system.

Principles help you think about something thoroughly and consistently. Overcoming disagreements between stakeholders and even within groups of stakeholders is important. Agreement between stakeholder groups and within stakeholder groups contributes to harmony. Lack of agreement contributes to dissonance. Principles help in the communications process.

The first very basic example proves the notion that a financial report logical system can be in equilibrium and be proven to be a properly functioning. Because the example is so basic it is hard to believe that first very basic example proves anything.

But consider three things. First consider the following expanded example that builds on the first example. The expanded example[66] builds on the accounting equation[67], "Assets = Liabilities and Equity", expanding that equation twice. The first expansion is adding seven *Elements of Financial Statements* explicitly defined in the FRF for SMEs financial reporting framework published by the AICPA[68]: assets, liabilities, equity, revenues, expenses, gains, losses. Second, I expanded on that framework in order to get to an additional level of detail. This level of expansion allows professional accountants to begin to wrap their heads around the idea that a financial reporting scheme[69] can be represented in machine-readable form and it looks very similar to the US GAAP and IFRS financial reporting schemes. This information was represented within an XBRL instance[70] and XBRL taxonomy[71] and has these 23 elements of financial statements:

---

[66] Human readable information about expanded example, http://xbrlsite.azurewebsites.net/2019/Core/core-audit2/evidence-package/

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

[68] AICPA, *Financial Reporting Framework for Small- and Medium- Sized Enterprises*, https://www.aicpa.org/content/dam/aicpa/interestareas/frc/accountingfinancialreporting/pcfr/downloadabledocuments/frf-sme/frf-smes-framework.pdf#page=21

[69] Charles Hoffman, CPA, *Comparison of Financial Reporting Schemes High Level Concepts*, http://xbrlsite.azurewebsites.net/2018/Library/ReportingSchemes-2018-12-30.pdf

[70] XBRL instance, http://xbrlsite.azurewebsites.net/2019/Core/core-audit2/instance.xml

[71] XBRL taxonomy schema, http://xbrlsite.azurewebsites.net/2019/Core/core-audit2/core.xsd

	Period [Axis]	
Elements [Abstract]	2020-01-01 - 2020-12-31	2019-12-31
Elements [Abstract]		
Elements of Financial Statements [Set]		
Assets	3,500	0
Current Assets	3,500	0
Noncurrent Assets	0	0
Liabilities	0	0
Current Liabilities	0	0
Noncurrent Liabilities	0	0
Equity	3,500	0
Equity Attributable to Controlling Interest	3,500	0
Equity Attributable to Noncontrolling Interest	0	0
Revenues	7,000	
Expenses	3,000	
Gains	1,000	
Losses	2,000	
Net Income	3,000	
Investments by Owners	1,000	
Distributions to Owners	500	
Enhanced Elements of Financial Statements Added [Set]		
Liabilities and Equity	3,500	0
Net Cash Flow	3,500	
Net Cash Flow from Operating Activities	3,500	
Net Cash Flow from Investing Activities	0	
Net Cash Flow from Financing Activities	0	
Income from Ordinary Activities of Entity	4,000	
Income from Peripheral or Incidental Transactions of Entity	(1,000)	

These core, high-level elements of financial statements were used to create shells of each financial statement. For example, here are the beginning and ending balance sheets:

Balance Sheet [Abstract]	Period [Axis]	
	2020-12-31	2019-12-31
Balance Sheet [Abstract]		
Assets [Roll Up]		
Current Assets	3,500	0
Noncurrent Assets	0	0
Assets	3,500	0
Liabilities and Equity [Roll Up]		
Liabilities [Roll Up]		
Current Liabilities	0	0
Noncurrent Liabilities	0	0
Liabilities	0	0
Equity [Roll Up]		
Equity Attributable to Controlling Interest	3,500	0
Equity Attributable to Noncontrolling Interest	0	0
Equity	3,500	0
Liabilities and Equity	3,500	0

The four financial statements were tied together within the machine-readable representation[72] just like they are tied together in any paper-based or "e-paper" based representation:
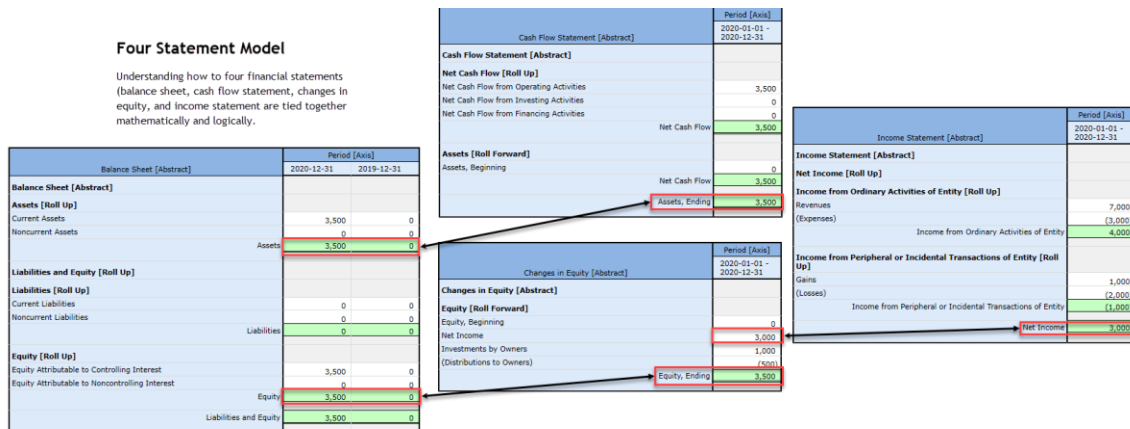
Machine-readable rules that are provided within the XBRL-based financial report as statements to prove that the statements made to report facts are consistent with what is expected per the machine-readable rules. An XBRL processor and XBRL

---

[72] Four statement model, http://xbrlsite.azurewebsites.net/2019/Core/core-audit2/FourStatementModel.jpg

formula processor confirms that the reported facts are, in fact, consistent with what is expected per the machine-readable assertions (i.e. rules)[73]:

#	Label	Result	Rule
1	0 = (Equity{T0} + (Revenue{P1} - Expenses{P1} + Gains{P1} - Losses{P1}) + (InvestmentsByOwners{P1} - DistributionsToOwners{P1})) + Liabilities{T1} - Assets{T1} (ASSERTION_CORE_CONCEPTUAL_FRAMEWORK_RECONCILATION)	Pass	0= ($Equity_BalanceStart + $Revenues - $Expenses + $Gains - $Losses + $InvestmentsByOwners - $DistributionsToOwners) + $Liabilities_BalanceEnd - $Assets_BalanceEnd
2	Net income foots (ASSERTION_Core_ROLLUP_NetIncome)	Pass	$NetIncome = ($Revenues + $Gains - $Expenses - $Losses)
3	Equity roll forward (Equity{P0} + NetIncome + InvestmentsByOwners - DistributionsToOwners = Equity{P1}) (ASSERTION_CORE_ROLLFORWARD_Equity)	Pass	$Equity_BalanceStart + $NetIncome + $InvestmentsByOwners - $DistributionsToOwners = $Equity_BalanceEnd
4	Assets roll forward (Assets{P0} + NetCashFlow = Assets{P1}) (ASSERTION_CORE_ROLLFORWARD_Assets)	Pass	$Assets_BalanceStart + $NetCashFlow = $Assets_BalanceEnd
5	Accounting Equation (Assets = Liabilities and Equity) (ASSERTION_CORE_Equality_AccountingEquation)	Pass	$Assets = $Liabilities + $Equity
6	Accounting Equation (Assets = Liabilities and Equity) (ASSERTION_CORE_Equality_AccountingEquation)	Pass	$Assets = $Liabilities + $Equity

And so, the first thing to consider is this rather small be significant expansion of the first very basic example to this slightly more detailed example that provides what amounts to the key high-level concepts or "cornerstones" of the foundation of a financial report.

Second thing to consider is that imagine if one were to keep going into more, and more, and more detail of a financial report. It is not that much of a stretch to recognize that if the XBRL-based financial report is kept in a state where it is proven to be properly functioning and have all the other characteristics of a well-defined and properly functioning logical system.
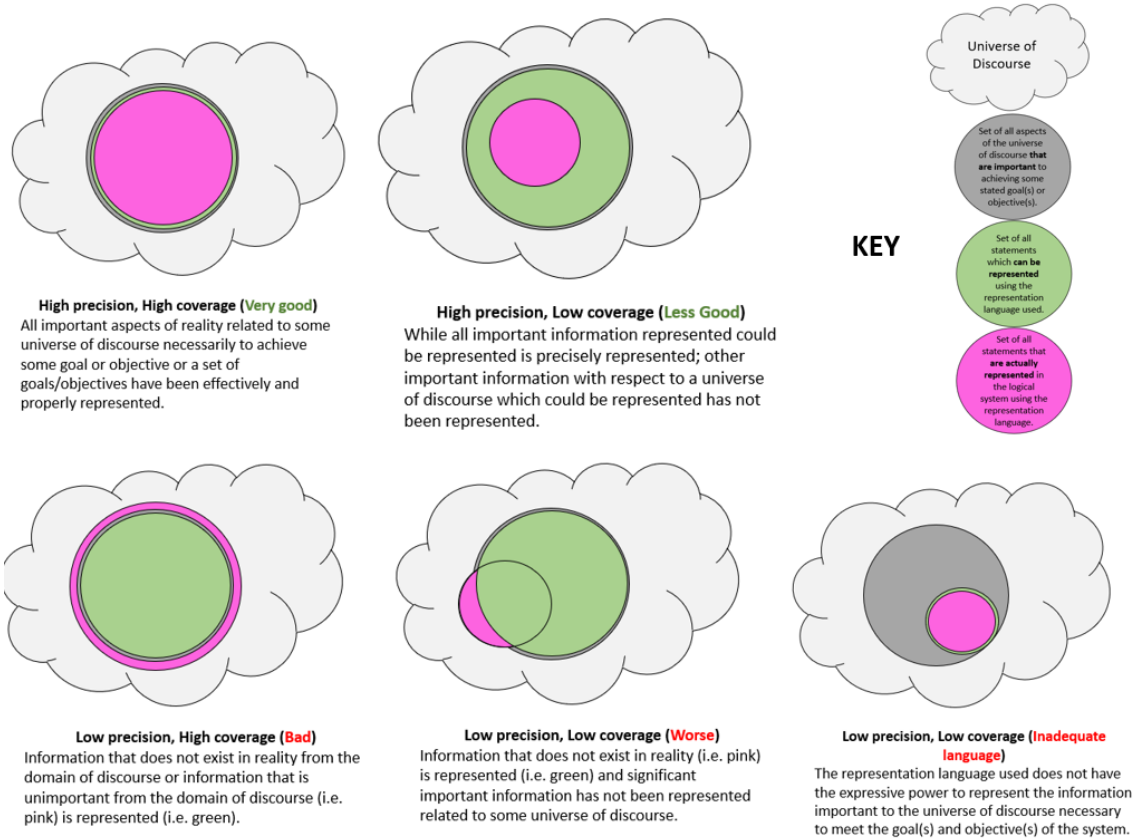
Basically, you keep building, and building, and building on this well established and rock-solid foundation until you have a "fully expressed" financial report logical system.

Another way to measure if a logical system is fully expressed is to use the notions of "precision" and "coverage" as is explained by C. Maria Keet, *An Introduction to Ontology Engineering*[74], pages 8-9. Inspired by Keet's graphic and notions, I created the following graphic which slightly modifies her version to try and make it clearer[75].

---

[73] Mathematical assertions, http://xbrlsite.azurewebsites.net/2019/Core/core-audit2/evidence-package/contents/index.html#BusinessRulesSummary.html

[74] C. Maria Keet, *An Introduction to Ontology Engineering*, pages 8-9, https://people.cs.uct.ac.za/~mkeet/files/OEbook.pdf#page=23

[75] Charles Hoffman, CPA, *Measuring Precision and Coverage*, http://xbrlsite.azurewebsites.net/2019/Core/core-audit2/MeasuringPrecisionAndCoverage.jpg

High precision, High coverage (Very good)
All important aspects of reality related to some universe of discourse necessarily to achieve some goal or objective or a set of goals/objectives have been effectively and properly represented.

High precision, Low coverage (Less Good)
While all important information represented could be represented is precisely represented; other important information with respect to a universe of discourse which could be represented has not been represented.

KEY

Low precision, High coverage (Bad)
Information that does not exist in reality from the domain of discourse or information that is unimportant from the domain of discourse (i.e. pink) is represented (i.e. green).

Low precision, Low coverage (Worse)
Information that does not exist in reality (i.e. pink) is represented (i.e. green) and significant important information has not been represented related to some universe of discourse.

Low precision, Low coverage (Inadequate language)
The representation language used does not have the expressive power to represent the information important to the universe of discourse necessary to meet the goal(s) and objective(s) of the system.

And so, the point is that if one keeps the statements that describe the report and the reported facts in equilibrium and in a state of being properly functioning and one continues to do this until the financial report logical system is fully-expressed; then one would have a provably well-defined logical system. I am going to test this by creating a complete representation of the AICPA's FRF for SMEs financial reporting framework[76].

Third and lastly, consider the clarity of the description of the financial reporting scheme conceptual framework and the fact that the description is in machine-readable form and that automated machine-based processes can be used to both clarify and prove the financial reporting scheme.

1.14. Understanding the Logical Errors that Occur

There are common situations of logical errors that occur in XBRL-based financial reports. The document *Proving Accounting, Structural, Mathematical, and Other*

---

[76] Charles Hoffman, CPA, FRF for SMEs Ontology, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/frf-sme/documentation/Home.html

Logic of XBRL-based Financial Reports[77] provides detailed information about nine common errors which are summarized here:

1. Using an existing base taxonomy concept intended to represent one class of concept inadvertently to represent some other class of concept.

2. Lack of clarity as to the meaning of extension concepts.

3. Unreported high-level subtotals.

4. Variability allowed for reporting high-level accounting relationships.

5. High-level financial report line item inconsistencies and contradictions.

6. Presentation relations model structure association logic errors.

7. Issues related to the mechanics of each report fragment.

8. Mathematical relations are not explained using machine-readable rules and then verified against that machine-readable explanation.

9. Verification that each report fragment that is required to be disclosure exists within the financial report.

Additional information is available that helps professional accountants and auditors understand the types of errors that exist in XBRL-based financial reports[78].

1.15. *Variability Caused by Alternative Intermediate Components*

While financial reports must fit within the elements of a financial report defined by a financial reporting scheme; financial reports are not forms. Specific variability is anticipated and allowed by financial reporting schemes such as US GAAP, IFRS, IPSAS, GAS, FAS, etc.[79] By far, the most variability that exists within a set of financial statements exists on the income statement. SFAS 6 discusses the notion of intermediate components[80] of comprehensive income:

"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."

Variability can be caused by choosing to report different common subtotals, by choosing to report specific line items rather than others, by either providing or not providing a subtotal such as "Noncurrent assets", etc. This variability is not random, arbitrary, or illogical; there are common patterns.

---

[77] Charles Hoffman, CPA, *Proving Accounting, Structural, Mathematical, and Other Logic of XBRL-based Financial Reports*,
http://xbrlsite.azurewebsites.net/2019/Library/ProvingAccountingStructuralMathematicsLogic.pdf

[78] Charles Hoffman, CPA, *Quarterly XBRL-based Public Company Financial Report Quality Measurement (March 2019)*, http://xbrl.squarespace.com/journal/2019/3/29/quarterly-xbrl-based-public-company-financial-report-quality.html

[79] Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*,
http://xbrlsite.azurewebsites.net/2019/Core/ElementsOfFinancialStatements.pdf

[80] FASB, SFAC 6, page 47, paragraph 77.

Here are common examples of variability using the accounting equation terms, association, and facts:

- **Add new term**: As mentioned, the term "Net Assets" is not provided in this model but is a permissible alternative to the term "Equity" for specific industries with which an economic entity is associated.

- **Add new association**: If a new term such as "Net Assets" is created, then a new association will always be necessary to relate the new term within some a structure to existing terms.

- **Change existing association**: If an existing association exists such as the association of "Equity" to "Balance Sheet"; it is possible to change that existing association and replace it with another permissible association.

- **Add new assertion**: If a new term is created it is likely that a new assertion will also tend to be necessary. For example, if the term "Net Assets" is created, the new assertion "Net Assets = Assets + Liabilities" would be created.

- **Change existing assertion**: Usually, existing assertions would not be changed but rather the existing assertion would not be used and would be replace by some other permissible assertion.

- **Add new structure**: An economic entity could decide to add an entirely new additional disclosure, creating a new structure that is used to articulate the associations between the terms that make up the new structure.

- **Change existing structure**: An economic entity could choose to modify the associations within an existing structure to provide a different but still permissible alternative disclosure.

- **Unreported fact**: An economic entity could choose to modify an existing structure to remove an association that provided an optional subtotal term and if so then the fact used to report that optional subtotal would not be provided within a report.

Note that "Change existing term" is not included in the list because it is never permissible to change the meaning of an existing term.

And so, the variability caused by these sorts of adjustments to some base model of a financial report must be managed and controlled in order be certain that the adjusted version of the model is still a permissible interpretation of a financial report and that the report is properly functioning.

Core Purpose of Financial Statement

The core purpose of a financial statement is to transfer information. Consider the following scenario:

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, inductive reasoning, etc.), **common financial reporting standard concepts and relations** (terms, relations, assertions for 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, relations, assertions), and common world view; and vice versa; and similarly for the investor and economic entity B.

1.16. Utility for Accounting and Transaction Processing

These same ideas apply not only to the financial report itself, but also to the trial balance[81] from which much of the report information comes, the transactions and processes that are used to account for information that ends up in reports, and even the non-financial and financial information generated outside the double-entry accounting system[82] such as from spreadsheets and content management systems.

1.17. Utility for General Business Reporting

The object here is to agree on a logical system such that the logical system can be leveraged to perform practical, reliable, dependable work. This logical system could be limited to only financial reports. However, I believe that it could be expanded to the more general business report; the financial report being a specialization of the more general business report. The system must be consciously unambiguously and completely as is necessary and practical in order to achieve a specific goal or objective or a range of goals/objectives. The system should error on the side of practicality and safety and perhaps sacrifice expressiveness and therefore functionality if necessary.

---

[81] Charles Hoffman, CPA, *General Ledger Trial Balance to External Financial Report*, http://xbrlsite.azurewebsites.net/2018/RoboticFinance/TrialBalanceToReport.pdf
[82] Charles Hoffman, CPA and Andrew Noble, PNA, BBus, *Introduction to the Fact Ledger*, http://xbrlsite.azurewebsites.net/2018/Library/IntroductionToTheFactLedger.pdf