Accounting Process Automation Using XBRL:

Elegant, safe, reliable accounting process and financial report creation automation leveraging the global standard XBRL

By Charles Hoffman, CPA (Charles.Hoffman@me.com)

Last Revised – February 27, 2018 (DRAFT)

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete." R. Buckminster Fuller[1]

Executive summary:

- Machine intelligence (sometimes called artificial intelligence) can be effectively leveraged to automate processes[2] such as transaction processing and financial report creation processes. But what technical syntax would you use?

- XBRL is a well-thought-out flexible global standard syntax for representing facts and describing relations between facts. XBRL can handle financial and non-financial facts. XBRL excels at handling complex sets of facts such as an entire financial report. But XBRL can also be used for smaller sets of facts, binding information together in a tidy package, bound together with the strong "steel wires" of business logic.

- The double-entry nature of accounting can be leveraged for accounting process automation and the automation of the creation of financial reports.

- A financial report is two graphs of information which must always be equal per the accounting equation[3].

- To understand the possibilities of what can and what cannot be achieved professional accountants need to understand how computers work[4].

- Information in this document has rather obvious applications in double-entry financial reporting and accounting process automation; however, these techniques can also be used with affect in general business reporting and other processes which are single-entry systems.

- The basic example provided by this document helps you understand the possibilities. Other examples referenced by this document show the complex financial information XBRL can work with today using existing commercially available software products.

---

[1] Good Reads, https://www.goodreads.com/quotes/13119-you-never-change-things-by-fighting-the-existing-reality-to

[2] Charles Hoffman, *Getting Ready for the Digital Age of Accounting, Reporting and Auditing: a Guide for Professional Accountants*, http://xbrlsite.azurewebsites.net/2017/Library/GettingReadyForTheDigitalAgeOfAccounting.pdf

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

[4] Charles Hoffman, *Closing the Skills Gap*, http://xbrlsite.azurewebsites.net/2018/Library/ClosingTheSkillsGap.pdf

Copyright (full and complete release of copyright)

Fundamentally, XBRL is a well-thought-out flexible global standard syntax for representing facts and describing relations between facts. XBRL can handle financial and non-financial facts. XBRL excels at handling complex sets of facts such as an entire financial report. But XBRL can also be used for smaller sets of facts, binding information together in a tidy package, bound together with the strong "steel wires" of business logic.

General Application Profile of XBRL for Process Automation

Think about what you would have to do if you wanted to implement accounting process automation, automation of the process for creating a financial report, or other sorts of automation. First you would have to establish a technical syntax for representing the business logic of the information. This is no trivial task. The semantic web stack[5] might be a viable choice to use as a basic syntax, but you still need to represent the underlying conceptual model and business semantics of your specific use case.

Another alternative is to simply use a general profile of XBRL. No implementation of XBRL ever uses 100% of the set of XBRL technical specification. Instead, those implementing XBRL create an application profile which specifies the allowed architecture of their individual implementation. What I did was take the best ideas of the best financial reporting implementation architectures[6], steal those ideas and create what I refer to as the *general application profile of XBRL*.

The advantage of this is that you get a thoroughly tested high-quality application profile of XBRL that can handle extremely complex financial and non-financial information. This application has a general business reporting conceptual model that is separate from the financial report conceptual model.

This document explains this technique for using this general application profile of XBRL to implement accounting process automation, financial report creation automation, or other process automation envisioned using machine intelligence[7]. Routine, highly repetitive, high-volume, error prone, mundane, and other such processes are the low hanging fruit which is ripe for the picking.

Admissible Information

How do you know if the information of a report is admissible? How do you know if the information meets statutory and regulatory reporting requirements? How do you minimize the risk of noncompliance? Because the information that defines "admissible" and outlines "statutory and regulatory reporting requirements" is written in books or other documents that are readable only by human beings and not by computer-based processes; the only way to determine if this information is correct is for a human to read the report.

But what if these statutory requirements and regulatory requirements were machine-readable? And what if the reports to be submitted were structured and also readable by machine-based processes?

---

[5] Comparing and Contrasting the Semantic Web Stack and the XBRL Stack,
http://xbrlsite.azurewebsites.net/2017/Library/SemanticWebStack_XBRLStack.pdf

[6] XBRL-based Digital Financial Reporting Profiles and General Business Reporting Profile,
http://xbrlsite.azurewebsites.net/2018/Library/Profiles-2018-01-24.pdf

[7] Shivon Zilis and James Cham, Harvard Business Review, *The Competitive Landscape for Machine Intelligence*,
http://xbrl.squarespace.com/journal/2018/1/31/harvard-business-review-the-state-of-machine-intelligence.html

That might mean, to some extent, the information within those reports is consistent with statutory and regulatory requirements and therefore reported information can be deemed to be conformant to or non-conformant with those statutory and regulatory requirements. Essentially, to the degree that a machine-based process can read a report and read the statutory and regulatory reporting requirements then automated machine-based processes can be used to determine the compliance or non-compliance with such statutory and regulatory requirements. Further, automated processes could also be used to generate such reports and to the extent metadata exists and machine intelligence harnessed assure such reports are admissible.

This document provides information related to a technique for using the global standard XBRL technical syntax for representing information and metadata related to processes for automating accounting processes, automating financial report creation processes, automating other business reporting processes, and other such processes. Examples relate to financial reporting only because that is the business domain that I am familiar with and the business use case that I am working to automate.

Double-entry Accounting

Single-entry bookkeeping[8] is how 'everyone' would do accounting. In fact, that is how accounting was done before double-entry bookkeeping was invented.

Double-entry bookkeeping[9] 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, it has a side effect of clearly firewalling errors as either accident or fraud. This then leads to an audit strategy. Double-entry bookkeeping is how professional accountants do accounting.

Double-entry bookkeeping was the invention of medieval merchants and was first documented by the Italian mathematician and Franciscan Friar Luca Pacioli[10]. Double-entry bookkeeping is one of the greatest discoveries of commerce and its significance is difficult to overstate. Which came first, double-entry bookkeeping or the enterprise[11]? 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?

While double-entry systems are appropriate for financial reporting application; XBRL will work for single-entry systems as well.

Information Focus, Not Presentation Focus

While many implementing XBRL-based systems for financial reporting tend to take paper processing systems and duplicate those and try and add on XBRL to the process, paper processing is not the best way to look at these sorts of systems. When an uninformed person looks at, say, an XBRL-based

---

[8] Wikipedia, *Single-entry Bookkeeping System*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Single-entry_bookkeeping_system

[9] Wikipedia, *Double-entry Bookkeeping System*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Double-entry_bookkeeping_system

[10] Wikipedia, *Luca Pacioli*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Luca_Pacioli

[11] 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

financial report which looks like a mess because the representation of the information is flawed one can get the impression that XBRL does not work very well. But should one look more deeply and sort out the representation problems associated with an improper mindset; then one can see that if XBRL-based systems are implemented appropriately they actually work very well[12].

Sort through the façade of "accountants are trying to duplicate existing paper-based reports rather than think about this in new ways". Remove the architectural flaws made by government regulators implementing XBRL. Think of smaller fragments of information organized properly. Think of engineering a system, testing the system to make certain that it works as desired, removing complexity where that is possible, etc. Basically, don't be distracted by the obvious errors made by others which you don't have to repeat. Think of the model of the information; don't think of the XBRL technical syntax.

Language of Graphs, Networks, and Trees

Graph theory[13] is a useful communications tool. A graph is an abstract idea that does not really exist in the real world. But, graph theory can be used to describe and explain real world information and structural relationships that can be reduced to a graph which is a set of objects and the relations between the objects. The graph is not the real world; the graph is just used to explain how the real world works.

Network theory[14] is part of graph theory and is the study of graphs. A network can be defined as a graph in which objects and relations between objects have been given attributes such as a "name" or a "role". A graph is defined in mathematical terms. Tools of **network science**[15] can be used to study these graphs.

A **tree**[16] 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. For example, one type of cycle is an infinite loop.

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

This language of graphs and trees is important to understand. Software developers tend to understand and use this language. It is also important to understand that these rules by which graphs, networks, and trees operate are guided by the rules of mathematics, logic, and set theory[17]. A complete discussion of graphs, networks, trees, etc. is beyond the scope of this document but I will provide examples where an understanding is important or helpful.

Difference between a Graph, a Tree, and a Lattice

The following graphic is helpful in understanding the difference between a graph, a tree, and a lattice which is another type of graph.

---

[12] Disclosure Best Practices, http://xbrlsite-app.azurewebsites.net/DisclosureBestPractices/DisclosureBestPractices.aspx?DisclosureName=BalanceSheet
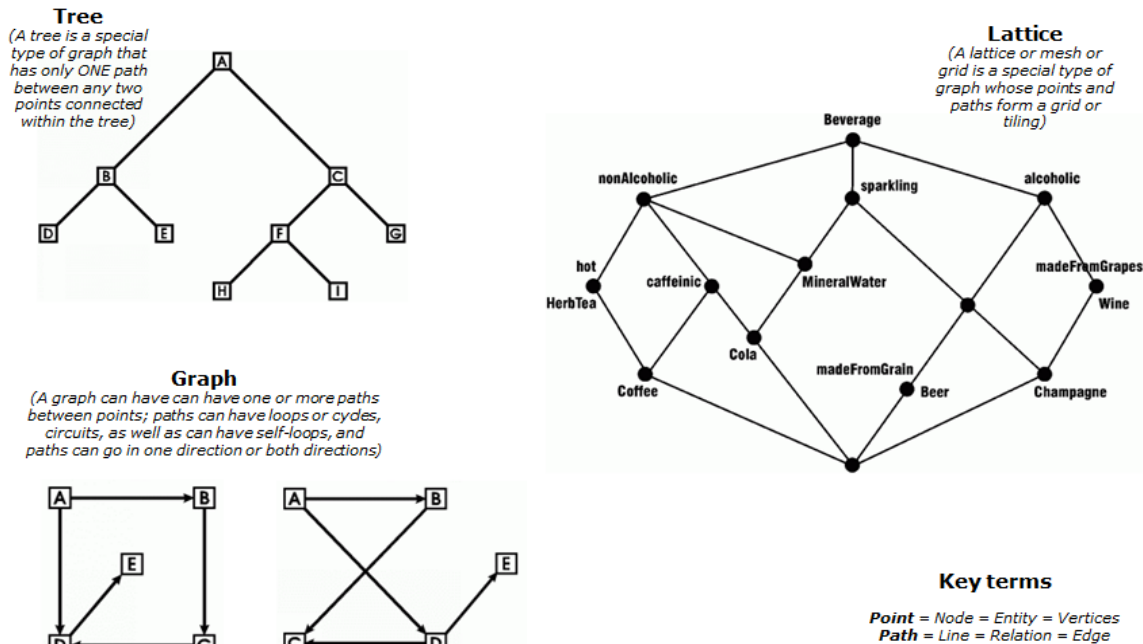
[13] Wikipedia, Graph Theory, https://en.wikipedia.org/wiki/Graph_theory

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

[15] Wikipedia, *Network Science*, https://en.wikipedia.org/wiki/Network_science

[16] Wikipedia, *Tree (Graph Theory)*, https://en.wikipedia.org/wiki/Tree_(graph_theory)

[17] Wikipedia, *Set Theory*, https://en.wikipedia.org/wiki/Set_theory

- **Graph**: A graph can have can have one or more paths between points; paths can have loops or cycles, circuits, as well as can have self-loops, and paths can go in one direction or both directions.

- **Tree**: A tree is a special type of graph that has only one path between any two points connected within the tree.

- **Lattice**: A lattice or mesh or grid is a special type of graph whose points and paths form a grid or tiling.

The bottom line is this: the best balance between power and safely is achieved by using **directed acyclic graphs**[18]. A graph is more powerful than a tree because graphs allow more flexibility than trees. All trees are directed acyclic graphs; but not all acyclic graphs are trees. Acyclic basically means non-circular. Circular relations are problematic, even catastrophic, and therefore should be avoided. Disjointed information is also problematic. Everything should be related in some way. Everything should be part of the full directed acyclic graph that explains something.

Basic Financial Report

In order to make some points that I need to make, I created a very basic financial statement that is representative of all the important characteristics of a financial report that I want to discuss. I have made the financial report available in both human-readable form[19], in machine-readable form[20], and I

---

[18] Wikipedia, *Directed Acyclic Graph*, https://en.wikipedia.org/wiki/Directed_acyclic_graph

[19] Human readable form, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/evidence-package

[20] Machine readable form, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/basic-SampleInstance.xml

created a document that explains the report[21]. I have created another version of this report using US GAAP XBRL Taxonomy concepts[22].

In addition, I have created more comprehensive examples of these reports that have exactly the same characteristics. One is called the XASB comprehensive example[23], the other is a reference implementation of an XBRL-based financial report prepared using US GAAP that would be submitted to the US SEC[24].

However, start with this easy, basic example and then you can test out these ideas on other more comprehensive and complex financial reports.

Finally note that not all information represented in this report would necessarily be disclosed in an external financial report. The purpose of this exercise is to test how a financial report will likely be represented internally, not necessarily reported externally.

Roll Up of Assets is a Graph

A balance sheet contains a roll up of "Assets" as can be seen in the example below. Assets is the root of the graph, that root has two branches "Current Assets" and "Noncurrent Assets", and then those two branches have leaves that make up the line items of the assets section of the balance sheet.

Reporting Entity [Axis]	30810137d58f76b84afd http://standards.iso.org/iso/17442	
Period [Axis]		
Implied [Line Items]	2018-12-31	2017-12-31
Balance Sheet [Abstract]		
Assets [Roll Up]		
Current Assets [Roll Up]		
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 [Roll Up]		
Property, Plant and Equipment	6,000	1,000
Noncurrent Assets	6,000	1,000
Assets	13,000	6,000

The graph is more apparent when you look at the roll up relations of the Assets section of the balance sheet:

Label	Rendered Value	Op	Reported Value	Calculated Value	Balance	Result	Name
Implied [Table]							fro:ImpliedTable
Assets	13,000		13,000	13,000	Debit	Verified	basic:Assets
Current Assets	7,000	+	7,000	7,000	Debit	Verified	basic:CurrentAssets
Cash and Cash Equivalents	4,000	+	4,000		Debit		basic:CashAndCashEquivalents
Receivables	2,000	+	2,000		Debit		basic:Receivables
Inventories	1,000	+	1,000		Debit		basic:Inventories
Noncurrent Assets	6,000	+	6,000	6,000	Debit	Verified	basic:NoncurrentAssets
Property, Plant and Equipment	6,000	+	6,000		Debit		basic:PropertyPlantAndEquipment

---

[21] Document that explains report, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/Documentation-XASB-GoodDebitsAndCredits.pdf

[22] US GAAP based example, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-US-GAAP/Documentation-US-GAAP.pdf

[23] XASB Comprehensive Example, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/taxonomy/Index.html

[24] XBRL-based filing using US GAAP, http://xbrlsite.azurewebsites.net/DigitalFinancialReporting/ReferenceImplementation/us-gaap/2017-05-07/

Roll Up of Liabilities and Equity is a Graph

A balance sheet contains also contains a roll up of Liabilities and Equity as can be seen example below. I will not explain the branches and leaf nodes because you probably get this basic idea from the explanation of the assets graph.

Reporting Entity [Axis]	30810137d58f76b84afd http://standards.iso.org/iso/17442	
Period [Axis] ▼		
Implied [Line Items]	2018-12-31	2017-12-31
Balance Sheet [Abstract]		
Liabilities and Equity [Roll Up]		
Liabilities [Roll Up]		
Current Liabilities [Roll Up]		
Accounts Payable	1,000	1,000
Current Liabilities	1,000	1,000
Noncurrent Liabilities [Roll Up]		
Long-term Debt	6,000	1,000
Noncurrent Liabilities	6,000	1,000
Liabilities	7,000	2,000
Equity [Roll Up]		
Retained Earnings	6,000	4,000
Equity	6,000	4,000
Liabilities and Equity	13,000	6,000

And again, the graph is more apparent when you look at the roll up relations of the Liabilities and Equity section of the balance sheet.

Label	Rendered Value	Op	Reported Value	Calculated Value	Balance	Result	Name
∨ Implied [Table]							fro:ImpliedTable
∨ Liabilities and Equity	13,000		13,000	13,000	Credit	Verified	basic:LiabilitiesAndEquity
∨ Liabilities	7,000	+	7,000	7,000	Credit	Verified	basic:Liabilities
∨ Current Liabilities	1,000	+	1,000	1,000	Credit	Verified	basic:CurrentLiabilities
Accounts Payable	1,000	+	1,000		Credit		basic:AccountsPayable
∨ Noncurrent Liabilities	6,000	+	6,000	6,000	Credit	Verified	basic:NoncurrentLiabilities
Long-term Debt	6,000	+	6,000		Credit		basic:LongtermDebt
∨ Equity	6,000	+	6,000	6,000	Credit	Verified	basic:Equity
Retained Earnings	6,000	+	6,000		Credit		basic:RetainedEarnings

Assets = Liabilities and Equity

As every accountant knows, the accounting equation specifies that "Assets = Liabilities and Equity". This is a fundamental rule of accounting, the basis for the double-entry bookkeeping system used in accounting.

And so, a balance sheet is basically two graphs of roll ups that must always agree.

Income Statement Connects to Liabilities and Equity via Retained Earnings

Again, not news to accountants; balance sheet accounts are real (or permanent) accounts and income statement accounts are nominal (or temporary) accounts. At the end of an accounting period the income statement is closed to retained earnings.

And so, the income statement is connected to the balance sheet via the retained earnings account. You can see this by looking at the roll up of retained earnings and the income statement together. Basically,

all of the income statement accounts are closed to "Net income (loss)" and that total is the change between the beginning and ending balance of retained earnings on the balance sheet.

And so, the point here is that the income statement is connected to the liabilities and equity graph via the roll forward of retained earnings.

Cash Flow Statement Connects to Assets via Cash and Cash Equivalents

Similar to how the income statement connects to the liabilities and equity graph via retained earnings; the cash flow statement connects to the assets graph via the net changes in cash. You can see this in two ways for the cash flow statement.

First, the cash flow statement has a roll forward of cash at the end of the statement. You can see this in the graphic below:

Secondly, if you look at the roll forward of cash and cash equivalents; the cash flow statement is essentially a formally organized summary of the changes in cash. Basically, the line items of the cash flow statement match up to the changes within the roll forward of cash and cash equivalents.

9

And so, the cash flow statement is connected to the assets roll up via cash and cash equivalents.

Primary Financial Statements are Two Graphs that Must Always Balance

As can be seen, the three primary financial statements are interconnected. This is not news to any professional accountant. It is likewise not news that the two graphs must always agree, this is a fundamental relationship in accounting.

There are two different types of relations that I am working with thus far: roll ups and roll forward. These two sets of relations work in tandem to document information contained in these two graphs of "Assets" and "Liabilities and Equity".

Breaking the information into pieces you get the following:

- **Leaf nodes** that contain information that represent the line items of the balance sheet, income statement, and cash flow statement

- **Metadata** that represents the **aggregation logic** of the leaf nodes; that aggregation logic includes

  - **Roll ups** as of some *point in time* (such as items on the balance sheet) or during some period of time (such as the items in the cash flow statement or income statement)

  - **Roll forwards** *across time* (such as the reconciliation of the beginning and ending balance of each balance sheet account)

  - **Adjustments** (no example is shown but this is known to exist) which documents a *change in value* (such as to correct an error).

- **Metadata** that represents the structure of information, mechanical relations, and other **business logic** of the information.

The supporting metadata allows both creators of information and consumers of information to be certain that they are working with high-quality information.

Roll Forwards of Balance Sheet Accounts Connects Beginning and Ending Balances

A trial balance contains transactions that provides the information about the changes that have occurred in every balance sheet account over some period of time. Those changes are summarized in the roll forward of each balance sheet account. We should the roll forwards of the cash and cash equivalents account and the retained earnings account.

Here we will show two more roll forwards. First, inventories:

Reporting Entity [Axis]	30810137d58f76b84afd http://st
Period [Axis] ▼	
Implied [Line Items]	2018-01-01/2018-12-31
Inventories [Roll Forward]	
Inventories, Beginning Balance	1,000
Purchases of Inventory for Sale	2,000
Costs of Sales 2	(2,000)
Inventory Written Off	0
Inventories, Ending Balance	1,000

This roll forward shows the changes between the beginning and ending balances of inventories. We will show one final roll forward, for long-term debt:

Reporting Entity [Axis]	30810137d58f76b84afd http://st
Period [Axis] ▼	
Implied [Line Items]	2018-01-01/2018-12-31
Long-term Debt [Roll Forward]	
Long-term Debt, Beginning Balance	1,000
Additional Long-term Borrowings	6,000
Repayment of Long-term Borrowings	(1,000)
Long-term Debt, Ending Balance	6,000

We could show every roll forward for every account, but I believe you get the idea[25]. To be clear, the point here is that every balance sheet account has a roll forward that reconciles the beginning balance to the ending balance of the account. The balances themselves appear on the balance sheet. The changes in the balances appear on the income statement or the cash flow statement.

Reporting Checklist Graph

For financial reports, what professional accounts refer to as a reporting checklist or a disclosure checklist is used as a memory jogger to make sure a required disclosure is not missed. While these reporting checklists are written to be human readable; they are essentially IF…THEN statements that are used by humans to make sure statutory and regulatory rules are complied with.

While it is not possible to represent all the rules of a reporting checklist in machine-readable form, it is possible to represent a portion of the information represented in a reporting checklist in machine-readable form.

---

[25] If you want to see the roll forwards of every balance sheet account, you can see those here, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/evidence-package/contents/index.html#BusinessRulesSummary.html

For the basic financial report we are working with, the following graphic shows the results of a basic automated reporting checklist[26].

#	Disclosure	Category	Level	Pattern	Applicable	Found	Disclosure Consistent	Representation Concept [TEXT BLOCK]	Representation Concept [DETAIL]	Checklist Category	Reason
▼ 1	Balance Sheet		Level4Detail	COMPONENT	True	True	CONSISTENT	NOT-EXPECTED	NOT-EXPECTED	Required disclosure	Disclosure always required, satisfied by Assets [Roll Up] and Liabilities and Equity [Roll Up]
2	Assets [Roll Up]		Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Assets	Part of disclosure	Disclosure always required
3	Liabilities and Equity [Roll Up]		Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Liabilities and Equity	Part of disclosure	Disclosure always required
4	Income Statement		Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Net Income (Loss)	Required disclosure	Disclosure always required
5	Cash Flow Statement, Direct Method		Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Net Cash Flow	Required disclosure	Disclosure always required
6	Receivables [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Receivables	Required disclosure	Disclosure always required
7	Cash and Cash Equivalents [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Cash and Cash Equivalents	Line item exists, then disclosure required	Required because line item basic:CashAndCashEquivalents was reported
8	Inventories [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Inventories	Line item exists, then disclosure required	Required because line item basic:Inventories was reported
9	Accounts Payable [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Accounts Payable	Line item exists, then disclosure required	Required because line item basic:AccountsPayable was reported
10	Property, Plant, and Equipment [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Property, Plant and Equipment	Line item exists, then disclosure required	Required because line item basic:PropertyPlantAndEquipment was reported
11	Long-Term Debt [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Long-term Debt	Line item exists, then disclosure required	Required because line item basic:LongtermDebt was reported
12	Retained Earnings [Roll Forward]		Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Retained Earnings	Line item exists, then disclosure required	Required because line item basic:RetainedEarnings was reported

Two types of reporting checklist rules were used for this basic example. First, rules stating that the balance sheet, income statement, and cash flow statement are *required disclosures* were represented. See lines 1 through 6 in the graphic above. Second, a rule was created for every balance sheet line item (i.e. leaf) stating that if the balance sheet line item was reported, then a roll forward of that line item is also required to be reported. See lines 7 through 12 in the graphic above. These reporting checklist rules were expressed using XBRL definition relations[27].

Disclosure Mechanics Graph

Disclosure mechanics rules check to make sure that a disclosure is represented correctly within a report. Disclosure mechanics rules test logic of the XBRL representation to make sure a disclosure is consistent with what is expected. For example the "Inventories Roll Forward" disclosure is required to (a) be represented as a roll forward (i.e. as opposed to a roll up) and (b) is required to contain the concept "basic:Inventories" as the beginning and ending balances of that roll forward.

The disclosure mechanics rules are also represented using XBRL definition relations[28]. The information related to the disclosure mechanics for the "Inventory Roll Forward" is machine-readable[29]. That same machine-readable information can be represented in human-readable natural language using a simple conversion process. The screen shot below shows the natural language representation of the "Inventory Roll Forward" business rules which are driven by the XBRL definition relations for that rule.

---

[26] Reporting checklist results, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/ReportingChecklistResults/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

[27] Reporting checklist rules expressed using XBRL definition relations, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/DisclosureMechanicsRules/ReportingChecklist-xasb-rules-def.xml

[28] Disclosure mechanics rules for all disclosures, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/DisclosureMechanicsRules/disclosure-mechanics-xasb.xsd

[29] Inventory disclosure mechanics rules in XBRL, http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/DisclosureMechanicsRules/1295-rules-def.xml

Rules: disclosures:InventoryRollForward

Disclosure mechanics validation for disclosure: **disclosures:InventoryRollForward**

This disclosure is currently missing from the taxonomy and instance; need to add.

This disclosure:

- **MUST** be represented as a **Disclosure Detail** with the concept arrangement pattern: **ROLL FORWARD**
  - ROLL FORWARD REQUIRES the beginning/ending balance concept `basic:Inventories`

Ok

A second use of the disclosure mechanics rules is for identifying the disclosure within the actual report. Below is a screen shot of the Line of Reasoning used by software algorithms to identify the "Inventories Roll Forward" disclosure.

Line of Reasoning: disclosures:InventoryRollForward

Pattern: ROLL FORWARD.

LEVEL 4 DISCLOSURE DETAIL

ATTEMPT 1: Looking for concept: `basic:Inventories`
LOCATED: Concept: `basic:Inventories` .
Concept `basic:Inventories` is not a ROLL FORWARD in network

- 1110 - Statement - Balance Sheet

Concept: `basic:Inventories` found and is a ROLL FORWARD in network:

- 1230 - Disclosure - Inventories

RESULT: [Found] One of the attempts succeeded.

CONCLUSION

CONSISTENT because the Level 3/2 Disclosure Text Block was NOT EXPECTED to be discovered and the Level 4 Disclosure Detail concepts were FOUND.

Ok

Essentially, what the Line of Reasoning is saying is that it found the concept "basic:Inventories" within the balance sheet, but it was not a roll forward and so that network was not used. The software continued searching and found the concept "basic:Inventories" again, this time it was within a roll forward, no other instances of this concept were identified and therefore the software reached the conclusion that this must be the "Inventories Roll Forward" disclosure.

13

Consistency Cross-checks Graph

Another type of relation that exists within a report is what is called the consistency cross-check. Consistency cross-check relations are used to make sure reported facts are consistent with the expected relations with other reported facts.

Consider the following. Suppose that the economic entity creating a report inadvertently reversed the concepts that were used to represent "Assets" and "Noncurrent Assets". If there were no consistency cross-check rules, then a machine-based process would not be able to detect this error and it would be up to human-based processes to detect the error.

However, since there is a business rule provided which states that "Assets = Current Assets + Noncurrent Assets". And so, should an economic entity reverse the concepts used to represent the facts for "Assets" and "Noncurrent Assets"; the machine-based process would detect this inconsistency.

#	Label	Result	Rule
1	CashFlowNet = CashFlowProvidedByUsedInOperatingActivitiesNet + CashFlowsProvidedByUsedInInvestingActivitiesNet + CashFlowsProvidedByUsedInFinancingActivitiesNet (FAC_CF1_NetCashFlowEqualsOperatingInvestingAndFinancing)	Pass	\$CashFlowNet = \$CashFlowProvidedByUsedInOperatingActivitiesNet + \$CashFlowsProvidedByUsedInInvestingActivitiesNet + \$CashFlowsProvidedByUsedInFinancingActivitiesNet
2	Liabilities = Current Liabilities + Noncurrent Liabilities (FAC_BS3_LiabilitiesEqualsCurrentPlusNoncurrentLiabilities)	Pass	\$Liabilities = \$LiabilitiesCurrent + \$LiabilitiesNoncurrent
3	Liabilities = Current Liabilities + Noncurrent Liabilities (FAC_BS3_LiabilitiesEqualsCurrentPlusNoncurrentLiabilities)	Pass	\$Liabilities = \$LiabilitiesCurrent + \$LiabilitiesNoncurrent
4	LiabilitiesAndEquity = Liabilities + Equity (FAC_BS4_LiabilitiesAndEquityEqualsLiabilitiesPlusEquity)	Pass	\$LiabilitiesAndEquity = \$Liabilities + \$Equity
5	LiabilitiesAndEquity = Liabilities + Equity (FAC_BS4_LiabilitiesAndEquityEqualsLiabilitiesPlusEquity)	Pass	\$LiabilitiesAndEquity = \$Liabilities + \$Equity
6	Assets = Current assets + Noncurrent assets (FAC_BS2_AssetsEqualsCurrentPlusNoncurrentAssets)	Pass	\$Assets = \$AssetsCurrent + \$AssetsNoncurrent
7	Assets = Current assets + Noncurrent assets (FAC_BS2_AssetsEqualsCurrentPlusNoncurrentAssets)	Pass	\$Assets = \$AssetsCurrent + \$AssetsNoncurrent
8	GrossProfitLoss = RevenuesNet - CostOfSales (FAC_IS1_GrossProfitFoots)	Pass	\$GrossProfitLoss = (\$RevenuesNet - \$CostOfSales)
9	Assets = Liabilities and Equity (FAC_BS1_BalanceSheetBalances)	Pass	\$Assets = \$LiabilitiesAndEquity
10	Assets = Liabilities and Equity (FAC_BS1_BalanceSheetBalances)	Pass	\$Assets = \$LiabilitiesAndEquity

Type or Class Relations Graph

Another type of relation that exists within a report is what is called the type or class relation. Type or class relations are similar to consistency cross-check relations except that they are not limited to mathematical relations. Type or class relations make sure that, say, a concept is not inadvertently used within the tree of relationships that are illogical. For example, the concept "Operating Expenses" which are indirect operating expenses should never be part of "Cost of Revenues" which are direct operating expenses.

No example of type or class relations is provided because the software vendor providing these examples does not support this sort of relation at this time.

Separate Forests within a Financial Report

While I have pointed out that the primary financial statements fit within two separate sets of graphs that have mathematical relations and other relations associated with those statements, and that those two graphs of mathematical relations must be equal because of the accounting equation, and that additional roll up and roll forward relations can be found in the disclosures of financial reports that further fill these informational graphs of mathematical relations; there are other graphs that exist that do not fit into one of these two graphs of relations.

For example, the future minimum payments under operating lease agreements is a roll up disclosure but the amounts disclosed by this disclosure are not posted to the trial balance and therefore they do not connect to any balance sheet line item.

Operating Leased Assets [Line Items]	Period [Axis]
	2016-06-30
Year Ending June 30, 2017	961,000,000
Year Ending June 30, 2018	996,000,000
Year Ending June 30, 2019	922,000,000
Year Ending June 30, 2020	833,000,000
Year Ending June 30, 2021	634,000,000
Thereafter	2,118,000,000
Total	6,464,000,000

As this disclosure does not fit into the assets or liabilities and equity forests; the disclosure exists within its own separate mathematical forest or graph. However, this disclosure does fit into other informational graphs[30].

Basic Disclosures Patterns Followed by All Other Disclosures

While this example was created to communicate specific information as straight-forward and simply as possible; don't be fooled by the basic nature of this example. There are additional relation patterns and additional disclosures that have been analyzed[31].

Further, two more comprehensive examples were referenced earlier in this document. Those examples show that far more sophisticated financial reports fit into this model.

Finally, all of the approximately 6,000 public companies that report to the US Securities and Exchange Commission have been proven to fit within the graph structure outlined by this document.

More Formal Mathematical Representation of Graphs

As stated, this document provides an information summary of the graphs of relations within a financial report. An improvement on this informal summary would be a formal summary in mathematical terms. As I am not a mathematician, I do not have the expertise to create such a formal summary.

For More Information

For more information about XBRL-based financial reports and how general business reports can leverage ideas used in financial reporting, please see the document *Intelligent XBRL-based Digital Financial Reporting*[32].

---

[30] Every report fragment in an XBRL-based report fits into the XBRL presentation relations and potentially into the XBRL definition relations if they are provided. As such, all parts of a report exist within one unified graph although that graph is not mathematical in nature.

[31] Best practice examples of 65 disclosures, http://www.xbrlsite.com/site1/2017/Prototypes/DisclosureAnalysis/All/

[32] Charles Hoffman and Rene van Egmond, *Intelligent XBRL-based Digital Financial Reporting*, http://xbrl.squarespace.com/intelligent-xbrl/

Technical Information

This section contains helpful technical information for those interested in understanding the scheme used to implement XBRL-based accounting process automation, financial report creation automation, or other such process automation.

All the XBRL used in these examples has been validated by four separate XBRL processors. All XBRL has been loaded and processed using two completely separate implementations of this scheme, one of which is commercially available for purchase today.

Run the Basic Example using XBRL Cloud (shown in this document)

To duplicate the processing of this example using XBRL Cloud, do the following.

1. Load this XBRL instance: http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/Basic-SampleInstance.xml

2. Use this schema for reporting checklist and disclosure mechanics validation: http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/DisclosureMechanicsRules/CombinedReportingChecklistAndDisclosureMechanics-XASB-basic.xsd

Report fragments and business rules results:
http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/evidence-package/

Reporting checklist and disclosure mechanics results:
http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/ReportingChecklistResults/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

More Complex Report (XASB comprehensive example)

To repeat this example with a far more sophisticated report:

1. Loat this XBRL instance: http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/taxonomy/company-instance.xml

2. Use this schema for reporting checklist and disclosure mechanics validation: http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/reporting-checklist/XASB-DisclosuresMechanics_Plus_ReportingChecklist.xsd

Report fragments and business rules results: http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/taxonomy/evidence-package/contents/index.html#BusinessRulesSummary.html

Reporting Checklist and Disclosure Mechanics results:
http://xbrlsite.azurewebsites.net/2017/Prototypes/XASB/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

XBRL-based Report Submitted to the SEC (reference implementation)

To repeat this example for an XBRL-based report which is complex and of the style that would be submitted to the SEC:

1. Loat this XBRL instance:
   http://xbrlsite.azurewebsites.net/DigitalFinancialReporting/ReferenceImplementation/us-gaap/2017-05-07/abc-20161231.xml
2. Use this schema for reporting checklist and disclosure mechanics validation:
   http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/reporting-checklist/Disclosures_BASE2_Plus_ReportingChecklist.xsd

Report fragments and business rules results:
http://xbrlsite.azurewebsites.net/DigitalFinancialReporting/ReferenceImplementation/us-gaap/2017-05-07/evidence-package

Reporting checklist and disclosure mechanics results:
http://xbrlsite.azurewebsites.net/2017/Prototypes/ReferenceImplementationSEC/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

Actual XBRL-based report submitted to the SEC by Microsoft

To repeat this example for an XBRL-based report actually submitted to the SEC by Microsoft:

1. Load this XBRL instance:
   http://www.sec.gov/Archives/edgar/data/789019/000156459017014900/msft-20170630.xml
2. Use this schema for reporting checklist and disclosure mechanics validation:
   http://xbrlsite.azurewebsites.net/2017/Prototypes/Microsoft2017/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

Report fragments and business rules results for Microsoft:
http://www.xbrlsite.com/site1/2017/Prototypes/Microsoft/evidence-package/#BusinessRulesSummary.html

Reporting checklist and disclosure mechanics results for Microsoft:
http://xbrlsite.azurewebsites.net/2017/Prototypes/Microsoft2017/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

Pesseract (working proof of concept to test feasibility of creating expert system)

Download a working proof of concept software application that supports this functionality: (download available until March 31, 2018)

http://pesseract.azurewebsites.net/#menu3

Additional Resources

This is where you can find the **conceptual model** used:

http://xbrl.squarespace.com/conceptual-model/

This document **explains the conceptual model**:

http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part02_Chapter05.1_IntroductionToTheConceptualModelOfDigitalFinancialReport.pdf

This document, *Blueprint for Creating Zero-Defect Digital Financial Reports*, explains the validation performed on financial reports:

http://xbrlsite.azurewebsites.net/2017/Library/BlueprintForZeroDefectDigitalFinancialReports.pdf

If you are completely lost and don't seem to understand any of this, please read *Closing the Skills Gap*, to understand why all of this is important:

http://xbrlsite.azurewebsites.net/2018/Library/ClosingTheSkillsGap.pdf